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The Production of Artistic Bronze Castings

A Discussion of the Various Methods of Molding Employed and the Alloys Best Adapted for this Line of Work

By C Vickers

WHILE bronze is not imperishable, it resists destructive influences of time and the elements to a greater extent than any other of the common metals and, in the absence of electrolysis, will last for centuries even when buried in the ground, which is proved by the many discoveries of ancient works of art. For this reason this metal is the most suitable medium for statuary and historical bronzes. To use iron as a constructive material for costly works of art, would be folly, as this metal disintegrates under the influence of air and moisture, and in time is reduced to its natural state. There are some exceptions, however, the most notable one being the iron shaft known as the Statue of Delhi, India, and which is popularly supposed to have resisted the ravages of the elements since 900 B. C. In the ancient city of Lincoln, England, a number of years ago a Roman sword was found while excavating in a city street, which was stated to be as bright as on the day it was made. However, it had been preserved with great care by the original owners who had enclosed it in many wrappings which were encased in a lead sheath. Such massive objects as iron cannon also last for several generations, but generally speaking, iron is not adapted for works of art which are to be preserved.

Another metal that has no real permanancy is zinc, either pure or alloyed. It possesses the advantage of cheapness and in recent years has been used extensively for castings for monuments. In the cast condition it is not nearly as durable as when rolled, and while it is not attacked by either moist or dry air at ordinary temperatures, it readily yields to the action of acids and alkalis and is reduced to a salt. While a zinc monument may endure for several decades, it is not to be compared with bronze for this purpose. All varieties of bronzes are not equal in their lasting qualities, as some alloys exhibit evidences of corrosion in a comparatively short time. A statue cast in Italy and erected in a public park in Milwaukee, was so badly corroded in a few years that repairs became urgently necessary to prevent its disintegration. Such difficulties can be avoided largely by the use of a metal of suitable composition, such as the standard statuary bronze adopted by Bureau Brothers, Philadelphia, at the suggestion of the United States government. This alloy fol-

FIG. 1—BRONZE FIGURE MADE BY THE WAX PROCESS

lows: Copper, 90 pounds; tin, 5 pounds; zinc, 5 pounds, and lead, ½ pound.

Some notable bronzes have been produced by the Siamese and it is claimed that the art was introduced into that country by the Chinese in the eleventh century. In the north of Siam, figures of the Buddha are found in large numbers on the sites of ancient temples which have been crumbling for centuries, leaving the majestic bronze statues enclosed by great forest trees. It is claimed that these figures are in an almost perfect state of preservation after centuries of exposure to a tropical climate. This is ascribed to the method of making the alloy, but it is more probably due to the fact that the figures remained standing and were, consequently, not in contact with the ground. Otherwise they would have been more or less corroded, regardless of the composition of the metal. The alloy used, however, was considered a great secret and was carefully guarded, although there is no reason to believe that a chemist would have experienced any difficulty in discovering the formula and could have duplicated the alloy, aided by the practical experience of a foundryman skilled in handling metals. The metal is known in Siam as Samrit bronze, which means the perfect or auspicious alloy. The formula of this metal was recently published in the *Daily Consular and Trade Reports*, issued by the United States bureau of manufactures. The formula was claimed to have been discovered in an old Siamese manuscript belonging to the late king of Siam, and the proportions of the alloy were as follows: Copper, 85.11 per cent; tin, 12.76 per cent, and mercury 2.13 per cent. The metal was made with appropriate oriental ceremonies. The tin was melted first and the mercury added, forming an amalgam which was alloyed with the copper in the proper proportions. At this stage it may be well to add a word of caution to the foundryman who may wish to make the mixture, but who is inexperienced in the use of tin amalgam. If the metal is thrown into the molten copper in the same manner as ordinary tin, an explosion will occur and the molten metal will be ejected violently from the crucible. The mixture should be made with great caution, the amalgam being added to the copper in small amounts only, as mercury, being liquid at ordinary temperatures, is vaporized rapidly by the heat of the molten copper. The mercury probably acts as a deoxidizer and its introduction with proper precautions, may have a tendency to clean the metal, but is not probable that the resulting alloy will be any better, if as good as a fair grade of phosphor bronze. Owing to the high content of tin, the metal is very hard and is too difficult to finish to possess any special value for casting modern statuary. It probably would make a good bearing alloy for heavy engine brasses, but would possess no advantage over the alloys commonly used for this purpose. As a formula it is interesting, but it is not a specially valuable contribution to brass foundry metallurgy. One of the most notable statues of Siam is that of the Buddha in the city of Pitsanuloke. This figure, which is supposedly of Samrit bronze, dates from the eleventh century, and ranks among the most beautiful objects of art that the Siamese have ever produced. Samrit bronze was used also for casting implements and vessels for sacred uses and was supposed to be endowed with mystic qualities. The casting of bronze Buddhas constitutes a distinct trade in Siam and the methods employed are similar to those pursued by the Japanese in making similar work. In the temples of Bangkok may be seen many fine statues of the Buddha, which compare favorably with the art bronzes of other countries.

FIG. 2—DOUBLE-FACE CAST BRONZE DOOR; WEIGHT, 3,600 POUNDS

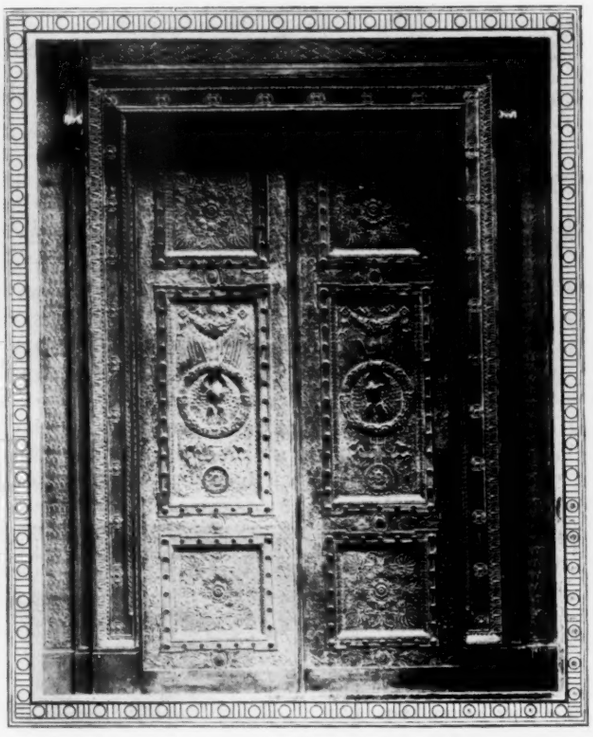


FIG. 3—BRONZE DOORS CAST BY THE WINSLOW BROS. CO.

Several methods of statuary molding were described in THE FOUNDRY, January, 1912, but the subject is by no means exhausted, as the molding

of such objects affords a large field for the exercise of ingenuity on the part of the founder and, therefore, methods may vary to a considerable extent. In some foundries the French method is followed, which consists of building-up the mold by a multitude of small cores and then attaching them to a backing. In other foundries the *circ perdue* or lost wax process entirely prevails, but no standard method is regularly followed, as in some cases the core is built-up first and the wax is modelled upon it, while in others a plaster of paris piece mold is constructed over the clay model of the statue, and from the piece mold, wax sections are obtained by pressing sheet wax into the mold. The pattern is then built-up of these wax sections in the casting pit. This method is advantageous in the event of failure. Another mold can be built-up easily of these wax sections without the necessity of again modeling the entire statue, while if the pattern is modeled in wax directly on the core, and the casting is lost, the sculptor must start from the beginning. The sectional wax method has some advantages over the French piece mold process, as the core can be centered with greater accuracy and is easier to vent and secure. Both processes begin with a clay model or pattern which has been made under the sculptor's supervision from the sculptor's small model. The small model is made of a non-drying composite clay, and is carefully preserved until the statue is completed. The full size model is made from ordinary modeling clay and must be kept covered with wet cloths to prevent the clay from drying and cracking. It is obvious, therefore, that a sand mold cannot be made from this clay model. A plaster of paris pattern must be built and to obtain this, a piece mold must be made over the clay statue, into which the plaster of paris can be poured to form a duplicate of the clay model.

The mold is constructed over the clay model in sections, each of which can be withdrawn from the model without tearing away the clay. Each of these sections must interlock with adjacent sections. When molding by the sand method the plaster of paris piece mold is used merely to obtain a cast of the statue in plaster, which is used as a pattern, the piece mold being destroyed during the removal from the plaster model. When molding by the wax process the plaster pattern is not necessary as the wax impressions are taken from the piece mold in suitable sections, and are then assembled into a hollow wax reproduction of the statue. The pattern for the seated figure illustrated in Fig. 1 can be built up easily of wax sections as the statue has a wide base. Every molder will understand that when starting the foundation of such a mold, provision must be made for rigidly securing the core and also for taking off the vent.

Beginning at the bottom, the wax sections are assembled on the base, and as they are built-up, the space they enclose is filled by the core with its spider and vent system. The thickness of the wax sections is equal to the desired thickness of the metal in the statue and is obtained when rolling or casting the wax into sheets. When the pattern is finished it consists of a wax reproduction of the original, full-sized model, inside of which is the core made of plaster of paris and loam, filled with core irons and vents, and from which chaplets or anchors may project through the wax covering. The gates are next attached to the mold. They are made of wax and extend to all parts of the wax figure. Wax risers and vents also are attached at suitable points and provision is made for the

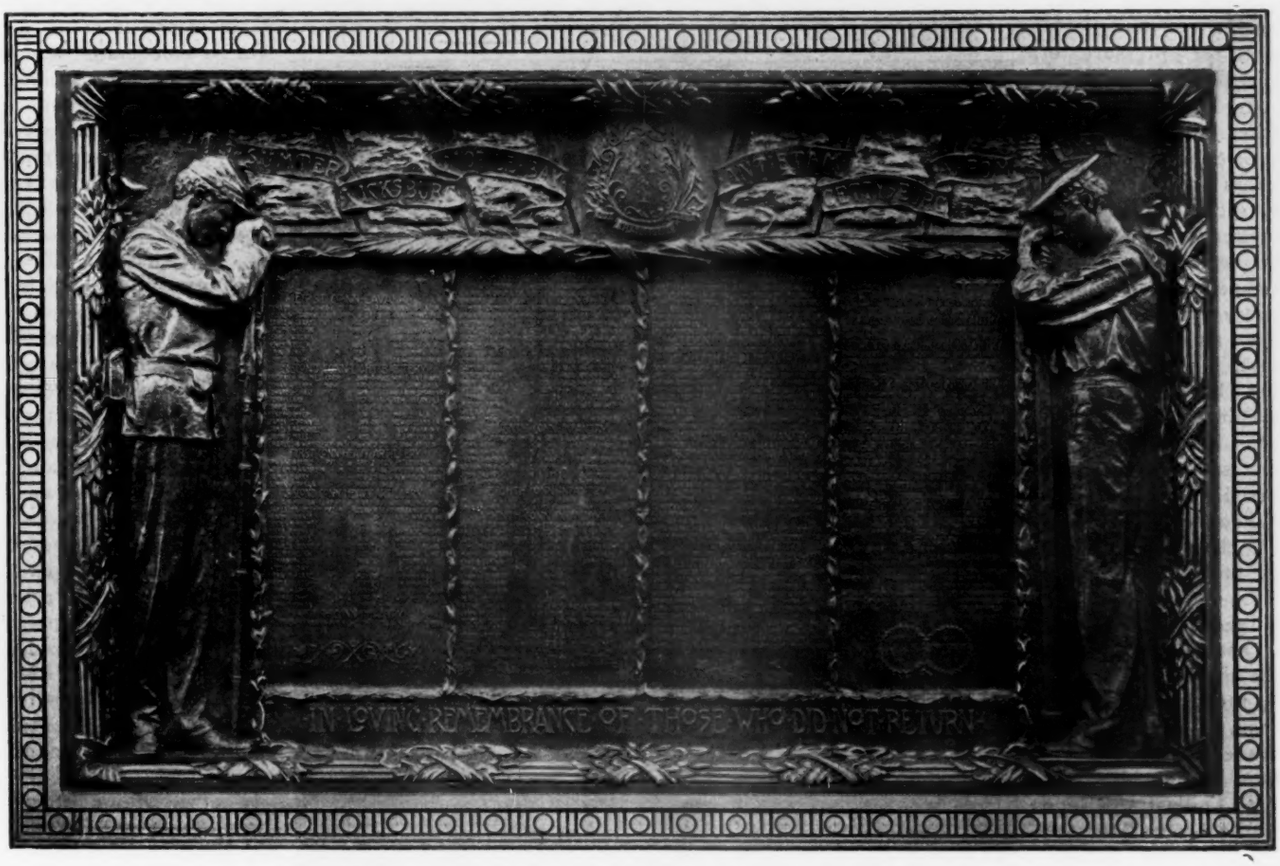


FIG. 4—BRONZE TABLET ON THE SAILORS' MONUMENT AT BRIDGEPORT, CONN.

wax to run out of the mold when the wax is melted by wax runners attached to the base of the figure. These project through the mold and when it is finished are melted out and form channels for the escape of the wax.

The mold is constructed over the entire wax figure with its network of gates, risers and vents, and consists of loam and plaster of paris, sometimes bonded with hair, mixed in such proportions that it will set or will become hard as the work proceeds. The molding composition must be strengthened as it is applied, by iron rods, nails, wire netting and other supports, to prevent it from cracking while being dried and to enable the walls of the mold to resist the pressure of the metal in the gates. After the mold is finished and the various projecting core anchors have been firmly secured, the wax is melted out. The mold is heated to a high temperature to remove every trace of moisture and wax. The mold is heated by fires built around it in a pit. As the wax runs out of the mold it is collected and saved for future use. When all of the wax has been melted out of the mold the runner openings are plugged and the mold is heated. While hot the mold is embedded in the pit, the runner basin is prepared and the cast is made before the mold cools. Fig. 1 illustrates one of the bronzes for the Soldiers and Sailors Memorial at Pittsburgh. It was cast by the Roman Bronze Works, New York, and is the largest seated figure made by this foundry. The figure is 11 feet 6 inches high and weighs 6,000 pounds. Chas. Keck was the sculptor.

Molding such figures into a pattern, by building-up wax sections, avoids the necessity of making a full plaster of paris model, such as is required by the sand method of molding. When the figure is modeled in wax directly on the core, the plaster of paris piece mold and the plaster of paris pattern are both unnecessary, provided the core can be modeled satisfactorily, but if the core is cast, a piece mold will be required to form the core, the same as in the other process. A method, the reverse of the one described, is followed by the Japanese in making large statues of heathen gods. These statues must conform accurately to the old forms, and for this reason the large foundries, the most important of which are located in Osaka, take pride in their wooden models, some of which are of enormous size, and hundreds of years old.

When a statue is to be made from one of these old patterns the first operation consists of building-up the core, which is made to correspond as far as possible to the outer form of the statue, but is smaller by the thickness of the metal in the casting. When the core is complete the mold is built over it. This consists of a piece mold made from the wood pattern in place of a plaster reproduction of the clay model. The piece mold entirely encloses the core with a space between the two parts equal to the thickness of the casting. When the mold is finished, melted wax is poured into the space between the core and the mold, and in this manner the wax pattern is formed. The mold is removed and the wax pattern, which is frequently very thin in comparison with the size of the figure, is finished and is used for the final molding operation. The mold is constructed of black river mud mixed with pulp made by hammering tough Japanese paper while in a wet condition. This material is used for the first layer applied to the wax model and is followed by layers of coarser material, the outer layer consisting of loam mixed with rice straw. While making the mold, great care must be exercised to provide for the drainage of the wax from all deep hollows, and in order to make the mold sufficiently strong to withstand the pressure of the metal, it is supported by rods, nails, wire netting, etc. After the mold is finished it is lowered into a casting pit where it is dried at a moderate temperature. After being dried the mold is subjected to a high temperature to burn out all traces of the wax. This is accomplished by filling the pit slowly with charcoal. The heating of the mold is continued until it reaches a comparatively high temperature, which destroys all organic matter. The mold is cast while hot. Gold and silver sometimes enter into the composition of Japanese bronzes, typical examples of which are as follows: Copper, 94.61 per cent; gold, 3.73 per cent, and silver, 1.55 per cent. Copper, 95.77 per cent; gold, 4.15 per cent, and silver, 0.08 per cent. In other alloys silver and copper are alloyed together as follows: Copper, 67.31 per cent and silver, 32.17 per cent, and copper, 51.05 per cent, and silver, 48.83 per cent. The ordinary alloys of copper used by the Japanese are generally high in lead, to which metal it is claimed is due the fine patina that distinguishes these works of art.

FIG. 5—A MAGNIFICENT EXAMPLE OF BRONZE BAS-RELIEF WORK

Some examples of this class of bronzes follow:

Copper, 81.62 per cent; tin, 4.61 per cent, and lead, 10.21 per cent.

Copper, 76.60 per cent; tin, 4.38 per cent; zinc, 6.53 per cent, and lead, 11.88 per cent.

A bronze of Chinese origin which has a peculiar dead-black appear-

ance, follows: Copper, 83 per cent; tin, 5 per cent; lead, 10 per cent, and zinc, 2 per cent. Stationary furnaces are not frequently used for melting the metal for statuary in Japan, but instead a shaft of fireclay or a series of stone rings are built around the crucible to enclose the fuel. The blowing apparatus is as peculiar as the furnace, but from a practical standpoint it is a better arrangement than a bellows, as it really forms a double-acting air pump, consisting of a cylinder, provided with butterfly valves on two sides in which a piston is moved by a piston rod. The cylinder is either circular or many-sided in section and the piston rod extends through the cover and is fitted with a cross-piece to facilitate its operation by hand. This blowing apparatus, which may or may not be equipped with an air chamber, delivers an almost continuous current of air of considerable volume, which melts the metal in an astonishingly short time.

Tablets, plaques and medallions form another class of artistic bronze castings in which the figures or scrolls are in relief on a flat background. This class of work often demands as much skill as full figures, as the undercut parts have to be treated in the same manner. A fine example of this class of work is shown in Fig. 4, which illustrates one of the large tablets on the Soldiers' Monument at Bridgeport, Conn. This tablet is 8 x 5 feet and weighs approximately 1,000 pounds. It was cast in one piece by the Jno. Williams foundry, New York City, from a model by Paul Winters Morris. The names of 150 veterans, with the name of the regiment, and company of each, and the place, date and cause of death, are inscribed in raised letters in four columns in the center. At the ends are the figures of a soldier and a sailor, beautifully modeled and rendered with incisive clearness. The pose of the soldier is historically correct as a portrayal of the position of *rest on arms* used in soldiers' burials during the civil war. This tablet is a rare study in design and relief modeling. Across the top of the tablet, in a scroll, are inscribed the names of the battles in which Connecticut troops fought and near the bottom is the inscription, "In loving remembrance of those who did not return." The monument is surmounted by a bronze representation of an officer's folded cloak, a cap and a sword, arranged to form a decorative effect. In casting sculptured bronze tablets, size does not always measure the exacting character of the work. Larger tablets than the one described have been cast, but they do not always involve as much detail. One, made later by the same foundry and placed on a bridge at Hartford, Conn., was 10½ feet long, 5 feet high and weighed about 1,500 pounds. This tablet was simple in design as it bore only a brief dedicatory inscription in relief. Perfect rendering of the minute details of the sculptor's modeling is the effect most insisted upon in these castings, and comparatively few brass foundries would care to attempt a casting involving the sculptured intricacy and the many small letters of the Bridgeport tablet. The patterns for these tablets usually consist of a plaster block, carrying on its face the sculptured design, and from this block a half mold is made, either in sand or plaster, as considered advisable, and the mold is then filled with a clay thickness, and another half mold is made from this, forming the cope. The first half is then shaken-out, as its surface has been destroyed by the clay thickness, and a new half mold is rammed off the plaster block to form the drag of the mold. The cope that was taken off the clay-lined half is closed over the new drag, and the mold is complete. Several precautions, however, must be carefully observed. The plaster block pattern must be embedded firmly in a half flask, so that there is no possibility of its shifting. This flask must form one of three interchangeable parts which must fit perfectly. The undercut portions of the plaster pattern must be rammed separately in the same manner as in figure casting, but as it is not necessary for the back of the tablet to conform to the undercut places, these can be smoothed out by the clay thickness so that the cope will lift without tearing the sand. In the final finishing of the drag of the mold the small cores from the undercut parts of the pattern must be firmly pinned to the body of the mold, so there will be no possible chance of their being washed away by the metal.

FIG. 6—BRONZE TABLET CAST BY THE WINSLOW BROS. CO.

FIG. 7—AN EFFECTIVE BRONZE PEDESTAL

A fine example of work in relief is shown in Fig. 5. This beautiful bronze was executed by Oscar L. Lenz and was cast by the Roman Bronze Works, New York City. It was placed in the Rural cemetery, Albany, N. Y. Sometimes, figures in relief are so modeled that there are no undercut parts, which greatly

simplifies the molding operation. This is not the case with the tablet, Fig. 5, which contains many undercut parts in the folds of the dress and in the figures.

The molding of the tablet shown in Fig. 6 involved none of the difficulties encountered in making the bas-relief, Fig. 5, as it contains no undercut portions. It is a fine piece of bronze work, however, and required careful molding to obtain a casting free from strains, misruns, cold-shuts and dirt. This tablet was cast by the Winslow Bros. Co., Chicago, and its purpose is fully explained by the inscription. The beautiful bronze pedestal, Fig. 7, was also cast and assembled by the Winslow Bros. Co., and is a remarkably fine example of the bronze founder's art. The bronze doors, Fig. 3, were made by the same company.

Another example of the same class of work are the bronze doors for the State Library and Supreme Court building, Hartford, Conn., shown in Fig. 2. These cast bronze doors are double-faced and are about 3 inches thick. Special hinges were made to support the great weight of the doors, which approximates 3,600 pounds. The doors are highly ornamented, and in each panel is reproduced the Connecticut state coat of arms. These doors were designed by Donn Barber, and were cast and erected by the Whale Creek Iron Works, New York City.

The Foundry Roof

By W. J. Keep

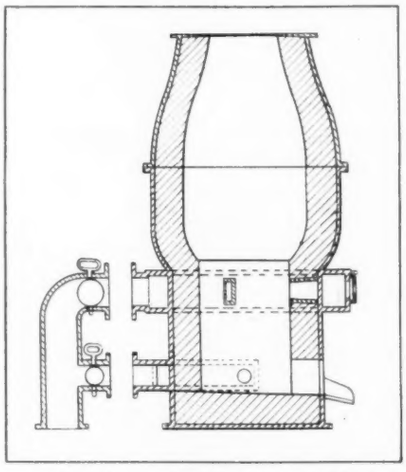
Question:—What do you consider the best construction for the foundry roof?

Answer:—The frame of the roof should be of steel construction and the distance from the foundry floor to the eaves should be not less than 20 feet. An even number of trusses at least 18 feet apart should be used. If the foundry is to be 96 feet wide, monitors should be built at points 16 feet from either end. These monitors should be at least 10 feet high over each alternate bay. The sides and ends of the monitors should consist entirely of windows and each alternate window should be arranged so that it can be tilted for ventilation. As the monitors extend crosswise, light will be admitted from every angle. If the foundry is to be 130 feet wide, the roof should be 10 feet higher than the one previously described, and on either side of the shop a row of windows should extend the entire length of the building.

I prefer to have a 7-foot brick wall extend around all sides of the foundry so that passers-by cannot look into the shop. The windows in the lower sash should all be arranged so that they can be tilted. We have experienced no trouble from dirt on the glass in our shop, which has been in operation for four years and during that time none of the windows, skylights, etc., has been cleaned. The glass seems to hold just a sufficient amount of dust to eliminate the glare of the sunlight. During the first two years we painted the lower row of windows with whitewash, but since that time no further applications have been made.

A French Emergency Cupola

A small cupola of French design, devised for emergency repairs, is shown in the accompanying illustration. The casing is in two sections and the lower portion can be detached for repairs to the lining; the upper part or stack is supported independently. The furnace is bottle-shaped and one of its peculiarities is



A FRENCH EMERGENCY CUPOLA

the double row of tuyeres. The upper tuyeres, three in number, are the melting tuyeres and are spaced equidistant around the circumference of the cupola, as shown at *A*. The two lower tuyeres are intended for heating the furnace only. These tuyeres pierce the shell at opposite sides and at right angles to the spout. The hearth holds from 300 to 400 pounds of melted metal, the weight of the charge being a little over 500 pounds. The fire is started with 66 pounds of coke, and between 600 and 700 pounds of metal can be melted and poured in an hour, including the time required for heating the furnace. The furnace is lined with fire clay, 4½ inches thick at the melting zone. This lining will last for 12 to 15 charges of 2,000 pounds each. The breast is 4 x 5½ inches. The cupola is mounted on a cast iron base, about 18 inches in height.

Pewter

Pewter is an easily fusible alloy composed of tin, lead, antimony and sometimes copper. It is closely allied to Britannia metal and is adapted for practically the same use, but is less costly, owing to the use of lead in the mixture. Lead, however, is a very undesirable ingredient of any alloy used for the manufacture of utensils. When the proportion of lead exceeds 16 per cent, the alloy is unsafe, and some countries have adopted laws limiting the percentage of lead contained in alloys that can be employed in the manufacture of utensils. In France the legal specific gravity of pewter is placed at 7.764 and any alloy exceeding this is regarded as unsafe, as it contains an excess of lead. Typical examples of pewter mixtures follow:

Tin, 82 per cent and lead, 18 per cent.

Tin, 80 per cent and lead, 20 per cent.

Tin, 79 per cent, lead, 6 per cent and antimony, 15 per cent.

Tin, 79 per cent; antimony, 7 per cent; copper, 2 per cent and bismuth, 2 per cent.

Explosive Antimony

In an address delivered before the Faraday Society of London, Eng., Prof. Cohen alluded to the singular behavior of antimony when electrically-deposited from a solution of antimony chloride in hydrochloric acid. When scratched, such deposits explode with the evolution of white vapors. The explosion is not violent, simply a puffing, and Prof. Cohen, in his investigations, deposits the metal on a platinum wire, thus obtaining a rod of antimony which explodes when slightly scratched with a glass rod. By depositing the antimony on the bulb of a thermometer it was ascertained that the explosion of the antimony actually developed sufficient heat to raise the temperature to 590 degrees Fahr., but theoretically to 734 degrees Fahr. It was established by careful calorimetric experiments that one gram of explosive antimony liberates 19.6 gram calories of heat during the explosion and the specific heat of antimony is approximately 0.05. The heat generation is, therefore, tremendous.

The Efficiency Movement in the Foundry*

Scientific Management for Casting Shops With a Discussion of the Application and Economies of This System

By C E Knoeppel

THE success of any business is but the sum total of the successes of the factors making up that business, and whether these factors are men, or materials, or machines, or methods, the rule is exactly the same. If only a few men are doing all that is possible; if materials are not being handled to the best advantage; if machines are idle part of the time; if methods are capable of being improved, maximum results cannot be obtained. There may be several ways of doing a thing, but there is only *one best way*, and the executive who does not search diligently for this best way is blinding himself to the possibilities in the law that commerce is but the adjustment of a number of relations to a financial end—the better the adjustment, the greater the results.

Mutualism

The foundry business, the same as any other business, should be based on *mutualism*. The executive wants low costs, the men employed want higher wages, and there is no reason why both should not realize their desires. If either ignores the interests of the other, *both lose out*. The aim, therefore, of *Scientific Management*, or whatever you choose to call it, is to bring about this seemingly illogical condition of higher wages and lower costs, through finding the best ways of doing things, and properly adjusting the various relations to the end that the proposition may be in the best possible working condition.

It is only within the past few years that the right kind of attention has been given to the matter of conserving our natural resources. We all know that this must be attended to, for we cannot only see this waste in material things, but it is felt in a business way—it touches the pocketbook. Did it ever occur to you, however, that there are enormous wastes in every phase of human effort, and that it is just as vital to take steps to stop this waste and conserve our resources in this direction? Every one will agree with the statement as regards material things, for the waste is a measurable quantity; while as to effort, the waste is more difficult to point out, hence more difficult to measure—it is with us, however, and sooner or later the right kind of attention must be given to it.

One-Sided Activities

In a sense, our activities have been one-sided. The right kind of attention has been concentrated upon the tangible elements, while the more intangible, but equally as important factors, have received but a small proportion of the attention that is possible. You have your specifications as to metal; you have your chemist who determines your standard practice as to material; your coke problems have received the attention of the best minds; molding machinery is receiving its share of attention and is being constantly improved; the cupola and its workings is far from being neglected; you have your standardization committees; transportation facilities in a number of instances have been developed to a high degree; in fact, all through the material and physical branch of your industry you have realized that it paid to first collect facts, then study these facts, and finally apply the best methods that your study revealed. How about the man end of the game? Has the same thought and study been applied to this branch of your industry?

Waste is the difference between what happens and what should be, and because this is so, we have to consider the elements of standardization, against which performance is compared, the result of which is a factor of efficiency—high or low—depending upon the care with which we set a standard, or the effort exerted to attain it. Consequently, we are confronted with two problems:

(1) The setting of the right kind of standards.

(2) The effort expended to attain them.

It has been said that business is a warfare between the management on the one side and the men on the other; in fact, an editor of a leading magazine said, a few years ago:

"Either side gets just what it grabs; hence, if I were a workman, I would go back into the union, and fight fiercely for a high, straight wage and eight hours, and if I were an employer, I would fight for straight piecework. Either side will get just what it has the power to take. It is the law, the fight of life."

Without going into the merits of this statement, it is, nevertheless, true that in the past there has been a feeling on the part of the men that before they did more or all that was possible, they would have to get more in wages; while, as regards the management, it has been considered that enough was paid for what was being turned out. As a result, both sides have suffered. If, therefore, a method had been devised for a more equal division of responsibility, and a greater gain to the men for an increasing output, it would have meant a getting together, which would have increased earnings for both the men and the company.

A Study of Conditions

By those who have had the opportunity, through actual experience, of studying the conditions as they exist, in an effort to better them, two conclusions have been reached:

(1) That a man can accomplish considerably more than he does.

(2) That the management, as business is at present conducted, does not know what constitutes the best a man can do.

A few words as to the evolution of the foundry industry will serve to show why this is so. Up to the present time, the molder has learned his trade largely through observation. He starts in as an apprentice; watches his fellows; gets a few pointers from them, and an occasional word from his foreman. He develops as well as he can under such conditions; drifts around from shop to shop, picking up points as to the varying lines of work, and in time becomes a full-fledged molder, his success being largely a matter of mentality, initiative, and the incentive furnished him to use his brain and muscle to the best advantage. In any foundry, he starts in as a man who some one

*Presented before the American Foundrymen's Association.

else has trained, and if he is able to make work of fairly good quality, with not too much loss and in a reasonable time, he stays. Is his subsequent training, however, anything beyond this mere manner of observing? On the other hand, if he does not suit, he is sent on his way for some one else to try out; when, under a constructive type of organization, his latent forces would be determined and brought out, and on the particular class of work for which he might be fitted, he would, no doubt, be successful.

Training the Foreman

As regards a foreman, the same condition is found. He comes to a concern trained through observation by some one else; is given a general idea of what he is expected to accomplish, but as he has a large number of men under him, his time for giving them the right kind of supervision is limited, and, as a result, he is in no position to study a job, properly standardize it, and see that the men attain the standard.

If he is better than the man before him, he stays until competition renders his best not quite good enough, when he makes way for another, who may not be as good, in which case he stays but a short time. If he is better, however, he stays until a higher level must be reached, and if he cannot attain this new level, it is figured that some one else can.

Even when the matter of management is considered, study will show that under present conditions a manager cannot work at his highest efficiency. The usual course is to engage a manager, to allow him a limited time in which to get acquainted with the conditions and the product, and after that to tell him to go ahead and get results. His time is devoted to securing business; pushing the work through the shops, many times regardless of the cost; running a *diplomacy bureau* for the benefit of the customers; worrying about finances and getting customers to pay their bills; listening to complaints from his men; settling disputes and quarrels, and a thousand and one other things that an executive is called upon to do in the course of seven or eight hours daily. While so busily engaged, in spite of the fact that he may have facts and figures in abundance regarding what has been and is being done, which he uses as best he can when he has a little time, it is easy to appreciate how it is possible, in the absence of a well-organized attempt to convert waste into money, for time to be lost, money thrown away, materials scrapped, etc., all because industrial endeavor seems to be conducted on the assumption that the more detail a man can look after in the course of a day, the greater he is as an executive and the more he should be able to accomplish. As a matter of fact, there is a limit to the amount of detail a man can handle, but practically no limit to the supervision that he can exercise.

What do we have as a result? The executive wants results, but he is unable to give more than a general idea as regards what he desires accomplished, so that it is up to his manager to reduce this idea into elements and factors, which he does as well as he can. The foremen are told that they must produce, and depending upon their ability they do as well as is possible in giving out the work, bettering conditions, stipulating how much they want produced, advising the men, etc. The men who finally get and make the work use their ability to a great extent in their own way. If they are not working fast enough or make their work incorrectly, it is not noticed except as the foreman in his travels around the shop happens to observe what is going on, in which case the men receive criticism or advice, as the case may be.

Usual Conditions

Because the conditions are often as outlined, it is not strange that through this shifted responsibility more is not accomplished. Men cannot advise themselves, and if the matter of equivalency as to time, number per day, and quality of product are left in a measure to them, or to a hasty observation by the foreman, it follows that because each man through his training is in a sense a *law unto himself*, the practice is anything but standard.

Constructive Work

To reverse the order of things, to build from the bottom upward, requires a constructive type of organization that erects on a firm foundation and in a scientific manner a structure that will consider the various elements entering into making the enterprise successful. These elements are:

(1) The man.
(2) The work to be done.
(3) The conditions under which he does his work.
(4) The planning of the work he has to do.
(5) Reward for individual effort.
(6) The records effecting the factors of the business.

What is he capable of and how can the best be secured from him? It has been found in handling pig iron that a man can do his best when handling 92 pounds at a time; in shoveling, 21 pounds to the shovel was found to be the best load; both being results of experiments made by Fred W. Taylor. In bricklaying, Gilbreath found that 18 bricks constituted the best load for a man to handle, and that by studying the motions of the man, they were reduced from 18 motions to five motions. It took scientific study to determine these facts, but they were worth while, for, as to pig iron, the increase per man was from 12½ to 47 tons; in shoveling, the amount was doubled or trebled; while in bricklaying the accomplishment per day rose from 1,000 to 2,700 bricks. Here, then, is a prime consideration—scientific study of the man.

Psychology of the Problem

In the foundry the work is largely a matter of motion—shoveling, ramming, slicking the mold, making cores, coring, finishing, closing, weighting, pouring, etc. Considered in this light, there are wonderful possibilities ahead of the foundry industry in this particular field, if we judge by what has been accomplished to date in this and other lines. As to the foundry industry, little, if any, study has been given to motions, trips, extra handling, etc., to determine the best a man can do, day in and day out, without injury to his health, for it should be remembered that scientific management does not mean slave-driving. So much for the practical side of the man's work.

The psychology side of the man is beginning to receive its share of attention, and again, as regards the foundry industry, there is a productive field awaiting development. We are all more or less governed by self-interest, and as every man possesses such faculties as initiative, imagination, energy, interest and concentration, any appeal to this self-interest awakens each faculty and more is accomplished as a result. Those among you who have made the greatest successes have been inspired primarily by self-interest. You called your imagination into play, dreamed of future successes, drew up mental plans which you desired to carry out, which aroused your interest to such an extent that your whole aim and purpose was centered upon what you had planned mentally. Depend-

ing upon your interest and concentration, your faculty of initiative forced you to get up and do, and your energy carried you through to success. These same qualities exist in every man. To what extent have they been developed in those under you? If, in addition, we consider that there is such a thing as a second wind in a mental as well as physical sense, the development of this side of a man's make-up is worth while undertaking.

In studying men, then, we must analyze what they do and how they do it, eliminate the unnecessary, instruct them how to do the necessary, inspire them with new and fresh interests, furnish them the incentive to use their heads and hands to better advantage, and you can get results from them which will be surprising as well as profitable.

As to the Work

The task is not completed, however, by just studying the man, for there must be a knowledge of what he has to do, as well as how he is to do it. The foreman can hand a molder a pattern; the molder can have a flask brought in; he can make and pour the mold, but he assumes a greater responsibility than is really his. Study will soon demonstrate that there is the unnecessary in the operations that go to make a job, just the same as there is the unnecessary in the work of the man. If the molder goes for gaggers, and then in setting them takes longer than is necessary, we have a double inefficiency, so that in studying the work the operation of going for gaggers would be eliminated, for the very good reason that a concern does not get productive capacity out of a molder when he is doing something that can be done for him by those less skillful and at less expense. This illustration holds as regards other items, such as mixing facing, going for nails, chucking or tightening flasks, and a number of other details that a study will reveal as existing to a degree in almost every foundry. Eliminate these unnecessary features, and we can standardize the operations; we can plan more intelligently, and we can put the responsibility for making a good mold squarely up to the man, not a responsibility that is likely to be detrimental to his interests, through furnishing him with tools and rigging that may not be best for the job in question, making him wait unnecessarily, etc.

After the work has been studied, the productive elements separated from those which are merely preparatory operations, it is then up to the management to assume full responsibility for bringing these conditions to the highest degree of efficiency. The molder, in a broader sense, is only the medium between the finished casting and what he is given to work with, as well as the conditions under which he works. We are all familiar with what he uses in his daily work, and as a molder can work efficiently only when he can use to advantage such items as patterns, cores, flasks, sands, nails, tools, etc., it would certainly pay to have this end of the work at its best. In a brief way the conditions capable of study and betterment are:

(1) Foundry orders — knowledge of and their following-up.
(2) Storage and handling of materials, supplies, etc.
(3) Selection of patterns, sweeps and core boxes.
(4) Repairing and alterating the above.
(5) Selection of flasks.
(6) Repairing and altering the above.
(7) Flask storage, piling, etc.
(8) Removal of castings, gaggers, rods, etc., from the sand.
(9) Tempering of molding sand for use by molders.
(10) Mixing of facing sand.
(11) Shop carrying arrangements.
(12) Supplying the molders with facilities.
(13) Furnishing the molder with proper tools.
(14) Crane facilities.
(15) Arrangements as regards the general shop labor.

As to Planning

One of the reasons for inefficiency in industrial endeavor is a lack of, or faulty planning, or dispatching, as it has been properly termed, the assumption of which is—no work is ready until everything is, or will be ready for the work. If the molder has to wait for a job, or pattern, or flask, or his cores, or to have new bars placed in his cope, faulty planning is responsible for inefficiency, which taxes the work with more than it should cost.

The elements of efficient dispatching are as follows:

(1) The parties concerned.
(2) Planning.
(3) Execution according to the plans.

All of these must receive proper attention. As to No. 1, this would consist of the foreman and those responsible for cores, flasks, rigging and shop labor. The next step—the planning—involves the following:

What is to be made?
By whom it is to be made?
Where it is to be made?
When it is to be made?
How it is to be made?
With what it is to be made?

While the execution is made up of three divisions:

(1) Knowledge of the plans made.
(2) Preparation for carrying them out.
(3) Carrying out the plans as per schedule.

If dispatching, as above outlined, is placed at the service of the men as regards jobs, patterns, flasks, cores, rigging, special features, conditions, the night work, supplies, crane service, tools and equipment, shop labor, etc., it would be but a short time before gains due to this one feature of the work would be such as to convince you beyond any possibility of questioning as regards the merits of efficient dispatching.

As to Reward

With dispatching so arranged to eliminate waits and delays; with conditions in the best possible state for working to advantage; with the work standardized both as to productive operations and as to time in which they should be done; with the men under proper direction giving their best energies, who is there unwilling to divide with them a share of the gain due to the elimination of waste and unnecessary effort? This would stimulate them, awaken a self-interest, and they would not only willingly assume their legitimate responsibility, but co-operate with you in turning out more.

This reward would be based upon individual merit according to the efficiency of each man, as shown by the relation existing between the time actually taken by him and what he should have taken on work that had previously been studied and standardized. In addition, rewards would be entirely distinct from wages, so that the men would have everything to gain and nothing to lose; in fact, the more a man could earn the better, for this would mean a higher efficiency, which stands for a low cost.

As to Records

Studying out the problem and drawing up the right kind of records would place in your hands actual and standard times and costs, efficiency of men, machines, foremen, departments and of the business as a whole. Such information would not only prove of value in enabling you as executive to keep in touch with the weak spots, but it would serve as the basis for rewards for individual efforts; as a guide in bettering the places needing attention, and as a means for better estimating and pricing, for you would

in time have a standard accounting enabling you to know in advance what things should cost.

In a few words, scientific management is the proper locking together of the six elements mentioned, each studied with reference to the others, the basis of which is a factor perhaps most important of all—*the fair deal*—for if the work is not based on justice and fairness, mutualism is not going to be the result that is absolutely essential for success. On this basis, organized labor has nothing to fear from this new type of management, for it is far from being a take-all-and-give-nothing proposition. It recognizes that there is a human element to be considered. Labor may be suspicious and *from Missouri*, but as the underlying principles of this new doctrine are applied and understood, they will in time come to the realization that it is a movement in the right direction—a move intended to benefit them as well as the concern for whom they are working.

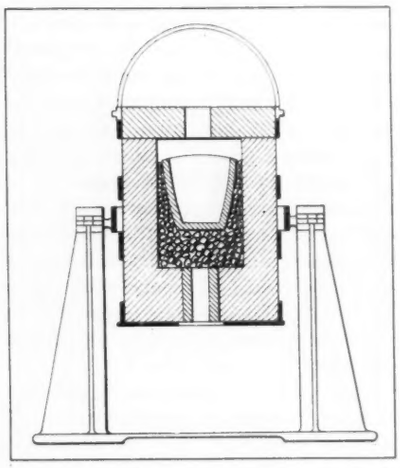


FIG. 1—SECTIONAL VIEW OF TILTING CRUCIBLE FURNACE

What Are the Possibilities?

Efficiency methods are applicable to your men as to the motions made and their psychological side; to the molding operations; the making of cores; the cleaning of castings; the cupola; the handling of materials and supplies; the use to which they are put; the physical conditions; the removal of castings at night; rejections, to determine and eliminate as far as possible preventable causes and other elements, all of which could be made to yield their share of gains through scientific study; setting up ideals and making it an object to those concerned to attain them.

Fred W. Taylor states that he made 30,000 to 50,000 experiments on 800,000 pounds of iron and steel, spending from $150,000 to $200,000 in an endeavor to get toolmaking down to a positive science. How well he succeeded is evidenced by the remarkable progress made in machine shop practice since the introduction of high-speed steels and a knowledge of the kind, shape and cut of tools, feed and speed of machines, etc. So with this matter of introducing efficiency methods. It will take time; it will cost money; it will have to be in charge of fair and open-minded men; it should be looked upon as something to be *put through* instead of simply *tried out*, but in the long run it will prove its value, as it has done to date, in a variety of lines.

Conclusions

Too sum up briefly: We have in our midst wastes due to the inefficiency of human endeavor as well as the inefficiency of material things. On the one hand, there is the prospect of allowing this condition of affairs to exist or changing these conditions through a better and more efficient type of management—a type having fixed laws and clearly defined principles applicable to all line of endeavor.

Getting back to the question asked at the outset, there is everything in it, for it means the elimination of loafing and soldiering; it will exert a powerful influence in eliminating disputes for the basic consideration, a fair day's work will be a matter of scientific determination; the men will earn greater amounts; costs will be reduced; co-operation will be secured; instead of discharging men or cutting their wages, efforts will be made to bring them to a higher level; you will in time gather together a mass of information on a variety of subjects which will constitute your standard practice; there should be no danger from strikes if the work is properly introduced, and the result can only be that you, your business, your industry and in time the whole country will feel the result of a management based on fairness, a proper division of responsibility and reward to those who assist in the elimination of waste.

An alloy of low specific gravity, suitable for use in aeroplanes, torpedo boats and for other purposes where an alloy of light weight is required, has been patented in the United States by Walter Rubel, of Berlin, Germany. The proportions recommended by the inventor follow: Magnesium, 94.99 per cent. and zinc, 6.1 per cent.

New Method of Heating Crucibles With Gas

By John B. C. Kershaw

The application of gaseous fuel to the heating of crucible and other forms of furnaces for melting and refining metals and alloys, will undoubtedly receive an immense impetus, if all the advantages claimed for the new method of *surface* or *flameless* combustion can be realized in practice.

It is, of course, no new discovery that under suitable conditions an explosive mixture of a combustible gas and air can be burned without any flame and with the production of a high temperature. Sir Humphrey Davy discovered this method of combustion nearly 100 years ago, but it has not been applied industrially until today. This new method of applying gaseous fuel to heating purposes may effect as great a change in our present methods of heating as the introduction of the incandescent gas mantle effected in the gas lighting industry ten years ago. The same principle, namely, incandescence, is common to both systems. In the one light is radiated from a glowing mantle of special construction and materials, in the other heat is radiated from a glowing bed of refractory material, specially prepared and graded into suitable sizes. Prof. Bone, of the Leeds (England) University, and C. D. McCourt, are the investigators who claim to have solved the difficulties attendant upon the industrial applications of this method of heating. The Radiant Heat Syndicate has been formed in Leeds, to develop and exploit this new system and an experimental furnace and boiler have been erected at Armley, near Leeds, where tests have been made and demonstrations have been given with the new process during the present year.

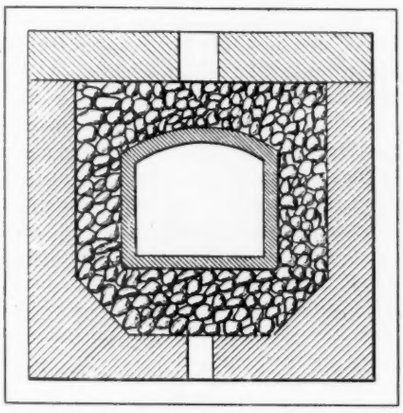


FIG. 2—SECTIONAL VIEW OF A MUFFLE

It is the purpose of the writer in this article, to discuss the application of the system to one purpose *only*,—namely,—the heating of crucible and muffle furnaces used for melting and refining metals, although the method is applicable to steam-raising and other purposes.

Description of the Furnace

The new gas-heated crucible furnace depends upon the flameless combustion of a mixture of gas and air, in calculated proportions, in a bed of highly refractory granulated material, surrounding the crucible which is to be heated. Fig. 1 is a section through a tilting crucible furnace of this type. The mixture of gas and air—the latter being present only in slight excess of the proportion calculated to yield perfect combustion—is injected by a blower through the narrow orifice in the base block of the furnace. As it impinges upon the incandescent bed of refractory material, combustion is almost instantly completed without any flame, and the heated products of combustion, as they pass away in an upward direction through the granular material surrounding the crucible, are rapidly deprived of their heat. The result is, that the bed of material is maintained at a high degree of incandescence and that chiefly by radiation, but also partly by conduction, this heat is imparted to the crucible. By varying the rate of combustion of the gas mixture and the proportion of air, perfect control is maintained of the temperature of the crucible and its contents.

The speed at which the gas mixture is blown into the combustion zone of the furnace must, of course, be greater than the rate at which the explosive wave is propagated through the mixture, otherwise the phenomenon known as *back-firing* will occur. This speed can be varied, either by altering the pressure under which the gas is supplied to the mixing chamber of the furnace, or by altering the size of the orifice in the furnace bottom. The proportion of air admitted to the mixing chamber can also be varied at will by regulating the air opening of the mixing chamber. Three checks upon the temperature can thus be exercised in this system of heating.

Muffle Furnace

Fig. 2 shows a muffle furnace arranged for the application of gas heating by flameless combustion. The upper limit of temperature attainable with this system is about 1,500 degrees Cent. The highest thermal efficiency (95 per cent) is obtained under these conditions, for the mixture of gas and air is then almost in theoretical proportions, and there is no unnecessary surplus of air being raised to this high temperature. Dr. Bone has pointed out that the great difficulty during the preliminary trials of the process has been to find a material which can withstand the temperature attainable. The system is applicable to all combustible gases, including the waste gases from coke ovens and blast furnaces. The broad advantages of this system of heating are, that a considerably higher temperature and efficiency are obtained than by the ordinary methods of heating by gas, and that the control of the temperature and heating effect is simple and instantaneous.

The Tin Pest

That tin, one of the cleanest of the metals, is subject to what is similar to an infective disease, is a fact well known to metallurgists and in an address on "The Allotropy of Metals", delivered before the Faraday Society of London, Eng., Prof. Cohen treats of this phenomenon and shows how the plague or pest of tin, as he well terms it, can be prevented and cured. He stated, in part, that 40 or 50 years ago, the decay of tin was first recognized and occurred in the case of some organ pipes in the castle church of Zeitz, Prussian Saxony. The phenomenon was next noticed at St. Petersburgh in 1868, where some blocks of bright, white Banca tin, which had been kept in the custom house sheds during the winter, had turned into a dull gray powder and had begun to crumble. On investigation it was ascertained that the case was not isolated, but was due to the exposure of the metal to cold.

The attention of Prof. Cohen was first drawn to the matter when a badly corroded block of tin was returned by a Moscow firm, because an adulteration was suspected. The tin was found to be very pure, containing not more than 0.05 per cent of impurities. In his experiments with this material Prof. Cohen found that the case of white and gray tin is much the same as that of ice and under-cooled water. Below its normal freezing point, water can exist in two modifications, the stable modification or ice, and the metastable condition of carefully under-cooled water and by a number of experiments given in detail in the address, Prof. Cohen demonstrated that this decay of tin was entirely caused by low temperatures. According to the theory he evolved, all tin should turn gray when the temperature falls below 64 degrees Fahr., and investigation showed that this was the case, but that the change proceeded very slowly at ordinary temperatures. At 23 degrees Fahr. the change was very marked as shown in the case of a block of good Banca tin placed in contact with gray tin, while another block kept at a temperature of 59 degrees Fahr. was not badly corroded after eight years.

Beginning of Decay

The decay or transformation starts from the particle of gray tin in the same manner as a small crystal of ice dropped into under-cooled water will become the nucleus of crystallization. In a similar manner, every particle of gray tin becomes a center for the formation of more gray tin, the transformation proceeding very slowly in the dense metal, the particles of gray tin acting like the germ of disease, and in this sense it may be said that the tin is infected and that all tin is liable to infection with the tin disease or tin pest. In the cold galleries of museums where tin coins and art objects are kept, the danger of tin infection is particularly great and the disease is found to be very prevalent. The disease does not appear to affect alloyed tin and in what manner the presence of other metals confers immunity is not at present understood. The discussion on this point developed the interesting fact that terne plates, whose coating consists of a lead and tin alloy, give good service in refrigerating plants, while tin plates always fail.

Storage of Tin

It is doubtful whether lead is subject to a similar disease as tin, but it was stated that Canadian architects distrust roofs built of iron, glass and lead, as the cold is believed to affect the lead. Whether lead is affected or not, it is certain that pure tin is especially liable to the tin pest. The gray tin is not oxide, although it contains some oxygen, as naturally it oxidizes more readily than the compact white tin. This oxidation may prevent the ready re-conversion by heat of the gray tin into ordinary white tin, but refusion of the gray tin with the addition of some carbon to reduce the oxide always yields good white tin again. The conclusion to be drawn from the investigations of Prof. Cohen are that tin should not be stored for any length of time in places where it will be subjected to very low temperatures.

Test Results of a Sand-Blasting Machine*

A Discussion of an Interesting Series of Experiments Made Under the Actual Conditions of Commercial Practice

By W T Magruder

THIS paper gives the records, results and conclusions of a series of quantitative tests of a sand-blasting machine, under the actual conditions of commercial practice, which were made by David H. Ebinger and Robert A. Frevert, of Columbus, under the direction of the author, as their thesis for the degree of mechanical engineer from the Ohio State University in 1910. As it was evident that a complete solution of the problem of securing quantitative results under such conditions was impossible in the time available, certain of the variables which present themselves in such a problem were assumed to be constant: (*a*) the material to be sand-blasted; (*b*) the character of its surface; (*c*) the air-pressure best to use with each of these materials and conditions; (*d*) the size of the nozzle for different classes of work; (*e*) the angle to the surface of the work at which the nozzle should be held; (*f*) the distance from the work at which the nozzle should be held; (*g*) size, sharpness, kind, character, uniformity of size, and cleanliness of the sand, and the number of times it has been previously used for sand-blasting; (*h*) the relative dryness of the sand and of the compressed air of the blast; (*i*) the proportion of sand to air; (*j*) differences in commercial machines.

The conditions of this set of tests were as follows:

The material was pieces of cast iron which had been broken as test bars for transverse tests. They were 2 x 4 inches in cross-section and from 15 to 25 inches long. They had been cast diagonally on edge in one mold from one ladle of machinery iron.

Their rough surfaces were as uniform as were the bars themselves.

A new nozzle, 5-16 inch in diameter, was used for each test. To remove any unevenness of the interior surface of the nozzles, and to bring them all exactly to the same condition, sand was blown through each for two minutes previous to starting the tests. No tests have yet been made with other sizes of nozzles.

The sand used was Cape May grit, new, hard, sharp, clean, free from clay, and was such as is commonly used by the trade. It was obtained from a large storage bin in the works. It was thoroughly dried in a Pangborn sand dryer, shortly before being used. Great care was taken to avoid overheating it and so destroying its strength and cohesion. The sand was then passed through a No. 8 mesh screen. After use in the machine, it was weighed, sifted, reweighed and discarded. New sand was used for each test.

The sand was dried as described. The compressed air was passed through a separator to relieve it of moisture from the atmosphere and oil from the compressor.

No attempt was made to regulate and adjust the proportion of air to sand. All tests were run with the regulating valve wide open.

No comparisons were made of the operations or results from different machines on the market.

Upon the three remaining variables, the air pressure, the angle between the surface of the work and the nozzle, and its distance from the work, the quantitative experiments were made.

The regular equipment of the D. A. Ebinger Sanitary Mfg. Co., Columbus, was used for these tests. It had been recently installed for use in sand-blasting cast iron ware before enameling. It consisted of one sand-blasting machine, made by the Thomas W. Pangborn Co., Jersey City, N. J., having a sand capacity of 4,000 pounds per charge. It was provided with a moisture separator, pneumatic sand separator, dust catcher and exhaust fan. The air was compressed by an air compressor, having a capacity of 138 cubic feet of free air per minute, and driven by an opposed gas engine of 25 horsepower capacity.

Fig. 1, *X*, shows the regulating and controlling valves, and *Y* is the mixing chamber for the air and sand.

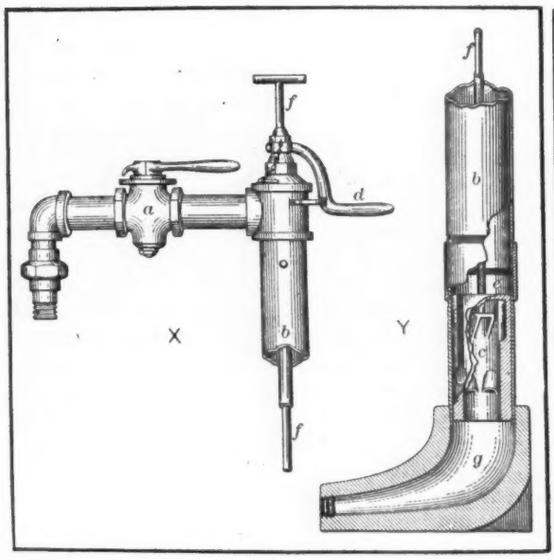


FIG. 1—THE REGULATING AND CONTROLLING VALVES ARE SHOWN AT X, AND Y IS THE MIXING CHAMBER FOR AIR AND SAND

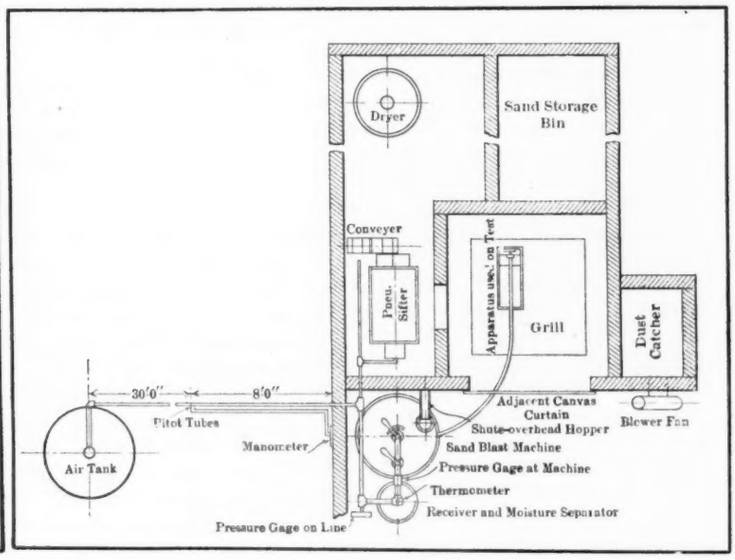


FIG. 2—LOCATION AND ARRANGEMENT OF APPARATUS

*Presented before the American Society of Mechanical Engineers.

Fig. 2 is a plan of the rooms and apparatus. Fig. 3 shows the sand-blasting box and sand catcher. Figs. 4, 5 and 6 graphically show the results obtained.

The compressed air coming from the compressor, enters the moisture and oil separator at the left of the machine, passes through the air regulator, *a*, Fig. 1, which has an indicator handle working over a graduated disc, enters and passes down through the cylinder, *b*, inside the machine, then through the air ports in the piston, *c*, and engages the entering sand. The ports in the top of the cylinder, one of which is shown, deliver the air to the sand chamber, so as to maintain equal pressure above the sand and to assist in insuring uniform flow. The sand-controller handle, *d*, moves on a quadrant, having limit stops for its off and on full position. This handle permits the piston, *c*, to be rotated in its casing, *e*, thereby opening, regulating and closing the sand ports by a single control. The stirrer and handle, *f*, connect with its fork which operates inside of the piston and mixing chamber for dislodging caked sand that may form under certain conditions. Ports, elliptical in shape, are located in opposite sides of both the piston, *c*, and the casing, *e*, and are inclined downwards, thus starting the flow of sand by gravity. The rotation of the piston by the controller handle regulates the opening of the ports and the flow of sand. The sand on leaving the ports is met by the air coming through the ports in the piston. They cross each other from opposite sides into the mixing chamber, *g*. By this cross flow, a swirling motion is produced and a thorough mixture of the sand and air is obtained in the rear part of the mixing chamber. The mixture is carried forward by the air pressure from the rear part, 2½ inches in diameter, to the hose connection where it is ¾ inch in diameter, thence through the hose to the nozzle, whence it is projected upon the casting to be sand-blasted.

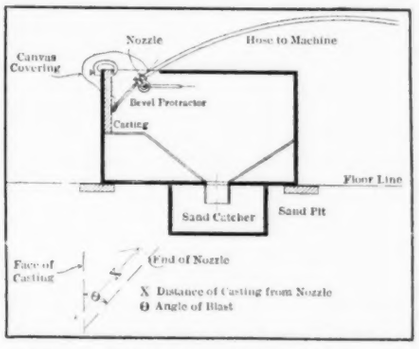


FIG. 3—SAND-BLASTING BOX AND SAND CATCHER

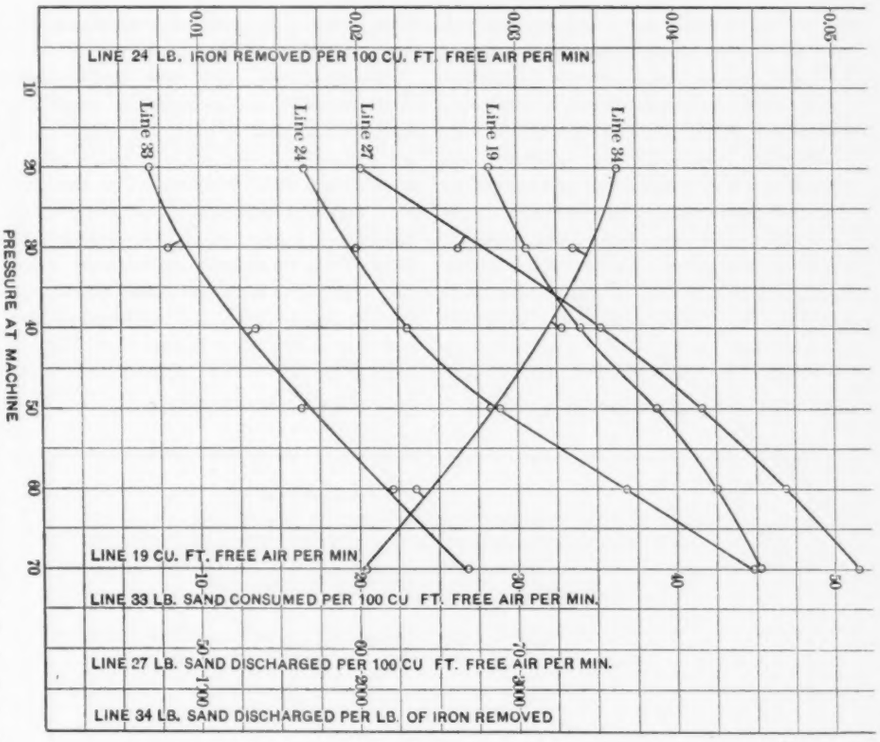

LINE 24 LB. IRON REMOVED PER 100 CU. FT. FREE AIR PER MIN.
Line 33
Line 24
Line 27
Line 19
Line 34
PRESSURE AT MACHINE
LINE 19 CU. FT. FREE AIR PER MIN.
LINE 33 LB. SAND CONSUMED PER 100 CU FT. FREE AIR PER MIN.
LINE 27 LB. SAND DISCHARGED PER 100 CU FT. FREE AIR PER MIN.
LINE 34 LB. SAND DISCHARGED PER LB. OF IRON REMOVED

FIG. 4—RESULTS OF TESTS IN RELATION TO AIR PRESSURE AT MACHINE

The air used was measured by a pitometer placed horizontally in a run of straight 1½-inch standard welded pipe in the main air line, and located at a distance from any fitting. The opening, ⅛ inch in diameter, of the dynamic tube faced the current of air from the receiver tank. The end of the static tube was trimmed off flush with the interior of the pipe. The tubes were connected by ⅛-inch pipes to the ends of a water manometer. The difference in the levels of the liquid in the two legs of the manometer indicated the difference between the dynamic and static pressures, and is a measure of the velocity head in inches of water. From the formula, $v^2 = 2gh$, the velocity of the air in the pipe was calculated. Deducting the area of the dynamic tip from the area of the opening in the pipe, gave the net area of the air pipe. The coefficient of discharge was taken as

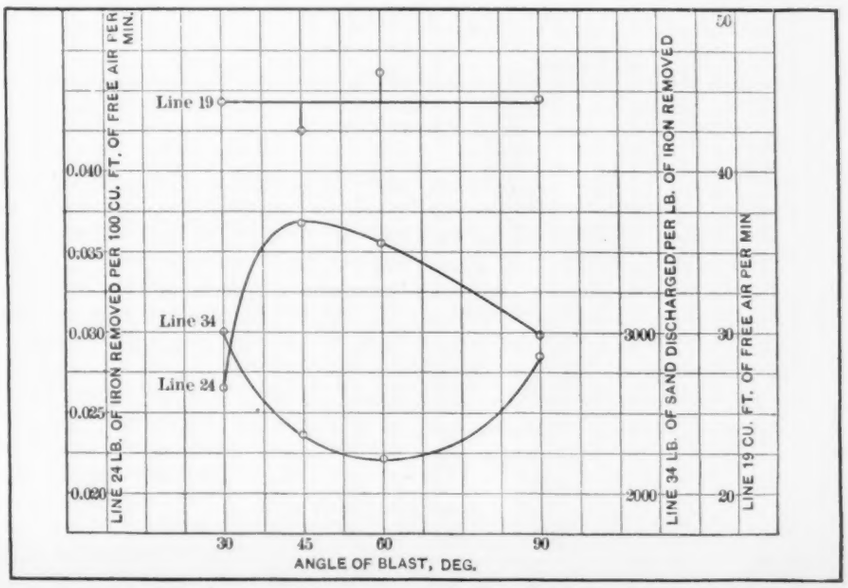

LINE 24 LB. OF IRON REMOVED PER 100 CU. FT. OF FREE AIR PER MIN.
LINE 34 LB. OF SAND DISCHARGED PER LB. OF IRON REMOVED
LINE 19 CU. FT. OF FREE AIR PER MIN
Line 19
Line 34
Line 24
ANGLE OF BLAST, DEG.

FIG. 5—RESULTS OF TESTS IN RELATION TO ANGLE OF BLAST

0.91. To remove the moisture that collected in the tubes, valves were placed in each of the tubes above the manometer, and pet cocks placed in the tubes directly above the valves. This arrangement permitted the blowing out of each tube before taking a reading of the pitometer. The temperature of the air in the line was taken just before it entered the stop valve at the machine. Calibrated pressure gages in the line and at the machine gave the desired pressures.

To collect the sand used during each test and also to control the blast, a closed box with a hopper bottom and a shelf at one end to support the test bar was prepared, as is shown in Fig. 3. The sand discharged during a test was collected in the hopper, removed, and weighed as total sand used. It was then sifted, and again weighed, thus giving by difference the amount of sand rendered useless by the test, and the amount of sand that might be used again in commercial practice. It was not again used in these tests.

The test bar was held in a vertical position in the sand-blasting box. Before and after blasting, it was carefully weighed on a platform scale of 250 pounds capacity by quarter ounces. The scale was carefully balanced before each weighing.

In each test the new nozzle was first brought to a uniform condition by discharging a blast of sand and air through it for two minutes under a constant blast pressure. The test bar was weighed and placed in position in the closed hopper box. The nozzle was then set by scale for its distance from the test bar and by bevel protractor for its angle with the surface of the test bar. The air regulator, *a*, Fig. 1, was kept wide open during the tests. The desired air pressure in the machine was secured and maintained constant by adjusting the stop valve in the supply pipe to the moisture separator. After starting the air blast and carefully adjusting the valve to maintain a constant pressure at the machine, the sand-controller handle, *d*, was moved to its open position at the instant of starting, thus allowing sand to flow into the mixing chamber and be forced by the blast of air out through the nozzle and against the test piece. Readings of the temperature and pressures of air on the main line and at the machine were taken at regular intervals of about two minutes. In closing down the machine at the end of a test, the sand valve was first closed and then the air valve; the test bar was weighed, and the difference of the two weights gave the amount of iron removed; the sand discharged was weighed, sifted and again weighed.

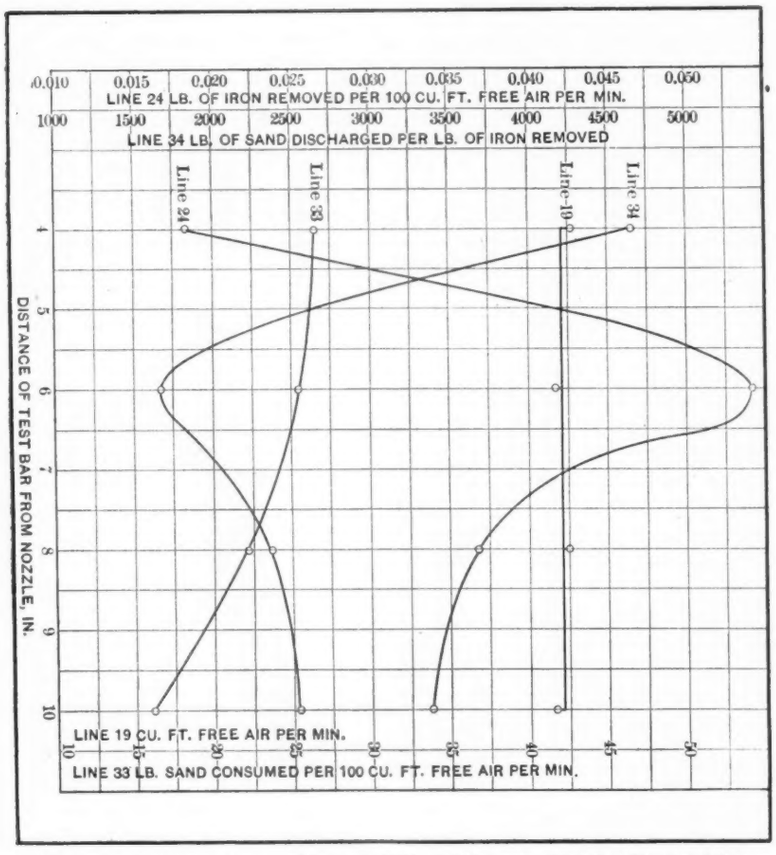


FIG. 6—RESULTS OF TESTS IN RELATION TO DISTANCE OF NOZZLE FROM WORK

Starting at 20 pounds corrected pressure at the machine on the first test, and increasing by 10 pounds up to and including 70 pounds pressure, the variation in the effectiveness of the blast due to increase of pressure was obtained, with the nozzle set at 45 degrees and at 8 inches from the test bar.

In the series of tests, a constant pressure of 60 pounds was maintained at the machine, and the nozzle set at 8 inches from the test bar. The angle was varied from 30 to 90 degrees. The effectiveness of these angles of blast was in this way obtained.

In the third series of tests, the distance of the nozzle from the test piece was varied, the angle being set at 45 degrees and the air pressure maintained constant at 60 pounds.

Observations

It was noted that with no sand flowing, the quantity of air flowing approximated the theoretical discharge for the nozzle. On turning on the sand, the quantity of air flowing immediately decreased; and when the sand was *on full*, the amount of air discharged was only 40 to 50 per cent of the original quantiity.

With constant air pressure and with the sand-controller lever in its *on full* position, on account of its variation in the openings of the sand and air ports of the machine, about 30 tests were required to be made in order to get even fairly concordant results for the pounds of sand discharged per 100 cubic feet of free air flowing per minute. For constant pressure, variations in the pitometer readings were due to the variations in the sand flowing. As the quantity of sand decreased, the velocity and quantity of air increased, but the quantity of sand discharged per pound of iron removed also decreased. It would seem that further experiments might prove that at other angles than 30 degrees, and at other distances than 8 inches, and at other pressures than 60 pounds, less sand would be used per pound of iron removed if the sand-regulating valve was not open so much. This would make the energy of the individual grain of sand greater and its blasting effect larger. Furthermore, there would be less piling up of the sand on the surface being sand-blasted.

From these quantitative experiments on a cast iron test bar for these three variables, within the limits used, the results graphically shown in Figs. 4, 5 and 6, are as follows:

Results

For a constant distance of 8 inches, and at a constant angle of 45 degrees, betwen the nozzle and the test bar, the equivalent amount of free air delivered per minute, the iron removed, the sand discharged, and the sand used up per 100 cubic feet of free air flowing per minute, vary directly with the pressure; the per cent of usable sand remaining, and the amount of sand discharged per pound of iron removed vary inversely with the air pressure in the machine. This is shown graphically in Fig. 4.

With a constant pressure of 60 pounds in the machine, and a fixed distance of 8 inches from the nozzle to the test bar, the largest amount of metal was removed, and the least amount of sand was required to do it, when the angle between the nozzle and the surface of the work was from 40 to 60 degrees; Fig. 5.

With a constant pressure of 60 pounds in the machine and a constant angle of 45 degrees between the nozzle and the surface of the test bar, the largest amount of metal was removed, and the least amount of sand was required to do it, when the distance from the nozzle to the work was about 6 inches, Fig. 6.

With a constant pressure of 60 pounds and a fixed distance of 8 inches from the nozzle to the test bar, the amount of sand used varies as the directness of the blast.

With a constant pressure of 60 pounds, and a constant angle of 45 degrees between the nozzle and the test bar, the amount of sand used varies inversely with the distance of the nozzle from the test bar, Fig. 6.

For a constant angle of 45 degrees, and a fixed distance of 8 inches between the nozzle and the test bar, twice as much metal was removed at 56 pounds pressure as at 20 pounds; at 64 pounds as at 30 pounds, and at 72 pounds pressure as at 40 pounds; Fig. 4.

With a constant pressure of 60 pounds and a constant distance of 8 inches between the nozzle and the test bar, over 20 per cent more metal was removed with the nozzle held at 45 degrees than at 90 degrees to the test bar.

With a constant pressure of 60 pounds and a constant angle of 45 degrees between the nozzle and the test bar, 60 per cent more metal was removed when the nozzle was held at 6 inches than at 10 inches from the test bar.

Unless it can be shown that the extra cost of compressing 100 cubic feet of free air per hour to a pressure of 70 or 80 pounds per square inch exceeds the cost to compress it to 30 or 40 pounds by the cost of an hour of labor (25 cents), the higher pressures, delivered at an angle of about 45 degrees, and at a distance of about 6 inches from the work, are to be preferred for the sand-blasting of cast iron.

An Uncommon Job for the Foundry

By J. F. Buchanan

Foundry work, as a branch of engineering, is seldom esteemed or awarded the high place it deserves among the constructive arts. Possibly this is because the bulk of our modern foundry work is mechanical in character and consists of repetitions. From an engineering standpoint the adaptability of foundry work is best seen in some shop attached to an engineering establishment on the seaboard, or on foundry floors that are not used exclusively for the production of molds.

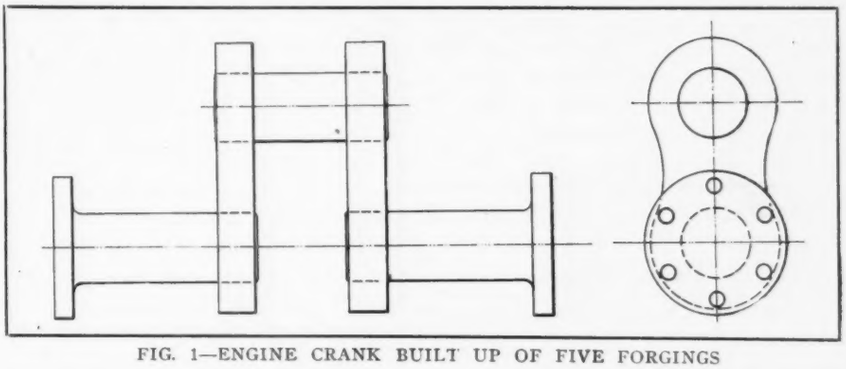


FIG. 1—ENGINE CRANK BUILT UP OF FIVE FORGINGS

Such operations as babbitting, burning-on, thermit-welding, or expanding metallic bodies by the heat derived from molten cast iron, do not come under the heading of foundry work in the ordinary sense. Yet, there are many places where the practical features of engineering are materially advanced by such work being undertaken in the foundry. An application of the last mentioned process, the expansion and separation of massive pieces of machinery, that may have been shrunk or driven together in sections, may be new and therefore interesting to some foundrymen.

The example that we select is one that should be familar to every one. Fig. 1 illustrates the elevation and plan views of a built-up crank, consisting of five separate forgings. The crank plays an important part in directing the forces which propel the machinery, and should a flaw develop in any of the parts, or if it were necessary to alter the angle of rotation, which is regulated by the position of the webs, the work of expanding the webs and releasing the studs, *A B C*, Fig. 3 would become an engineering repair. No doubt the work of heating and separating such a crank into its five components rightly belongs to the forge, but on the grounds of economy in supplying heat and expediency in handling, it is frequently done on the foundry floor.

A brief description will make clear the method of procedure. A hole is dug to receive the crank, in which it is levelled before being filled in again with sand. An open sand mold is formed around the web which is to be expanded. The dimensions of this mold are proportioned to the distance the heat is required to penetrate. For a large crank—and some marine engine cranks are very massive—it is better to divide the mold into sections by means of iron plates, previously claywashed and warmed, Fig. 2. Into each of these mold sections cast iron is poured. The heat travels steadily from the outside toward the center, until, on close observation, the pin, *A*, Fig. 3, is seen to be free. The foundry crane being already in position to take a strain, the first part is gently taken adrift almost as soon as the cast iron has set. The remaining sections are separated by

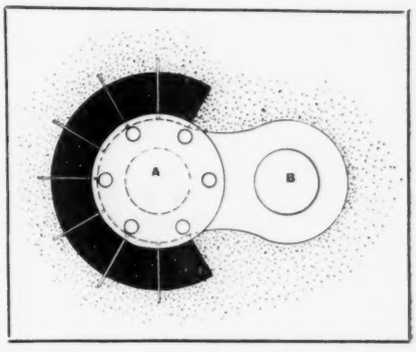


FIG. 2—PLAN VIEW OF THE MOLD

re-heating the process. There are two points of importance in carrying out this work. The first is, to pour into the mold just so much iron as is necessary to expand the web part while it sets. If too much metal is poured around the web the heat will travel before solidification takes place onto the stud and expand it also, causing it to stick and in this way prevent

the easy separation of the parts. It is also important to have the crank pin properly balanced so that when the pull is taken by the crane the strain will be vertical. Again, if the strain were taken before the cast iron in the mold had set, and the stud was not free, there would be the danger of lifting the crank bodily and allowing the still fluid iron to come in contact with the steam generated by the heat passing through the damp sand.

The work is simplicity itself, and the two points already noted are the keys to success. Figs. 2 and 3 show the sectional elevation and plan of the mold, with the mold shown in blank. Other applications of this simple, cheap process may suggest themselves to engineers and foundrymen.

Tissiers Metal

Tissiers metal is an alloy of copper, arsenic and zinc, the proportions usually being copper, 97 per cent; zinc, 2 per cent and arsenic, from 1 to 2 per cent. This alloy is supposed to be a good bearing metal, but as it cannot compete in that respect with any of the alloys commonly used, and particularly with the highly leaded metals, it has a very limited field of application. The use of arsenic in alloys is always attended with danger, as it is a very poisonous element, and while it is used to a limited extent in bearing alloys, there are other deoxidizing elements that can be substituted for it to good advantage.

Newark Technical School's Foundry Course

The Newark Technical School, Newark, N. J., has added a course in foundry practice, which is intended for those engaged in foundry work, whether as journeymen or apprentices. The instruction is largely in the form of lectures, no practical work, such as the making of molds or cores, being provided for, as it is assumed that all applicants who are already engaged in foundry work are desirous of improving their knowledge of the science and theory of foundry practice. For admission, the applicant must pass an examination in elementary arithmetic. The course covers two years and during the first year the classification and grading of pig iron is taught and includes a discussion of the influence of various constituents on its qualities and its selection for different purposes. Lectures are also given on the crystallization and shrinkage of cast iron, and the calculation of weights of different kinds of castings and metals. Cupola practice is also taught.

During the second year lectures on the following subjects are included in the course: Molding sands, varieties and uses; green and dry sand molding, liquid pressure in molds, blow-holes, segregation in castings, foundry facings, patternmaking, chill castings, selection of iron and design of chill, malleable castings, testing of cast iron and alloys, brass foundry work and lectures on

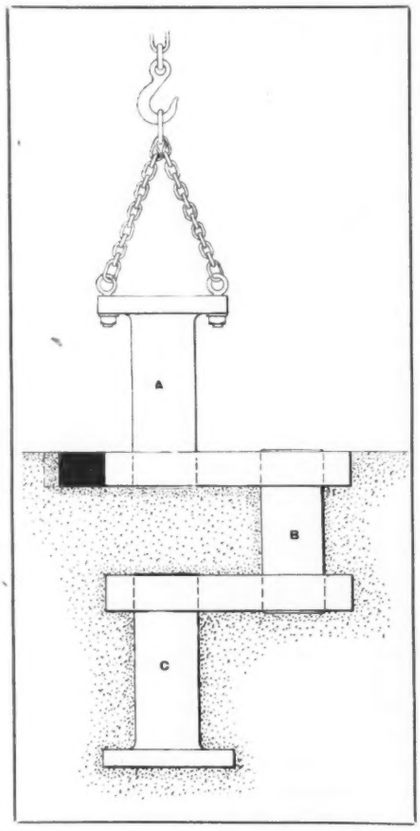


FIG. 3—SECTIONAL ELEVATION OF THE MOLD

the metallurgy of iron. Lectures on foundry practice are delivered two nights a week and two nights are devoted to drawing.

Shrinkage in Globe Valve Bodies

By N. W. Shed

Question:—We are experiencing considerable trouble from shrinkage in globe valve bodies in sizes from 5 to 10 inches. These shrinkage spots occur where the body and diaphragm join the flange. We have tried churning at this point and find that the iron is sound where churned, but shrinks around the churned spot. We have used a chill at this point, but leaks occur in other places, nearly always where the flange and body meet. The mixture we are using analyzes approximately as follows: Silicon, 1.72 per cent; sulphur, 0.10 per cent; manganese, 0.43 per cent, and total carbon, 3.44 per cent.

Answer:—The trouble arises from the heavy section of metal where the body and diaphragm join the flange. This heavy section cools very slowly. To cause quicker cooling at these places it would be well to drive cut nails into the mold so that the nail heads projecting into the molten metal would cause rapid cooling in the heavier sections. By using a higher silicon and phosphorus mixture it might be possible to keep the metal fluid longer and thereby diminish the shrinkage spots. This can be done by using a pig iron containing from 5 to 6 per cent silicon and 2.50 to 3.00 per cent phosphorus. About 10 per cent of this metal added to the charge would tend to remove this tendency to shrinkage spots. By raising the silicon alone, good results may be had. This can best be done by using A. E. Outerbridge's method of adding powdered ferro-silicon in the ladle.

Manganese Bronze

In a formula for making manganese bronze, recently patented, Jesse L. Jones, of the Westinghouse Electric & Mfg. Co., Pittsburgh, specifies the use of either a high speed or a magnet steel, in place of the wrought iron generally used. The composition of self-hardening steel is approximately as follows: Iron, 80 per cent; tungsten, 18 per cent, and chromium, two per cent. The composition of magnet steel is usually iron, 95 per cent, and tungsten, five per cent. The manganese bronze is made by the use of a hardener of the following composition: High speed steel, 62½ per cent; tin, 30 per cent, and ferro-manganese, 7½ per cent. To make the manganese bronze, 51 to 64 per cent of copper is melted in one crucible, and from six to 15 per cent of the hardener is melted in another pot. The molten hardener is added to the copper, after which the alloying metals are added, as follows: Zinc, from 35 to 45 per cent; tin, from 1-6 to three per cent, and aluminum, from 1-6 to eight per cent.

The American Plater

A Few Pointers on Nickelplating

By Seymour W Rowsbar

TO KEEP pace with the advance of mechanical and electro-chemical processes, every progressive plater finds it necessary to devote a portion of his time to the perusal of literature relating to his art. To remain satisfied with present accomplishments is not in accordance with the accepted standard of American enterprise. By constant application to his chosen profession the thinking man rises to a higher plane and strives for greater achievements. That this and succeeding articles may prove of some benefit to fellow platers, they will be confined to a discussion of the practical side of the modern process for the electro-deposition of metals and kindred finishes. It is not intended to introduce minute scientific detail or to enter into a complete account of the chemistry of electrolysis, but interesting topics will be discussed as comprehensively as experience and careful investigation will permit.

Nickelplating

As nickelplating is carried on to a greater extent by manufacturers in connection with their other processes than any other branch of electro-plating, this article is devoted to the electro-deposition of nickel. The quality of nickelplating in this country at the present time is much superior to the product of only a few years ago. Several great improvements in electro-deposition and the process of cleaning preparatory to the actual plating have been introduced, resulting in better color and more adherent deposits. These improvements are due to the combined efforts of the plater, manufacturer and supply house. When barrel plating was first attempted the idea was ridiculed; today the rotating plating machine is used for plating 75 per cent of the small work turned out of the plating plants throughout the world. The manufacturer found it necessary to produce and finish his ware at a lower cost and machines were introduced that have effected great manufacturing economies.

Ten years ago the electro-cleaning method was not generally known and was regarded by many as a secret process. The average scouring tank contained only one compartment, which permitted the contaminated rinsing water to be carried easily to the plating bath. As copper-plating before nickeling was more prevalent at that time than at present, this had a tendency to produce conditions in the nickel bath that, considering the average plater's knowledge at that time, were, to say the least, very perplexing. Today the electro-cleaning process is an acknowledged labor-saver and the scouring tank is divided or a tank containing clean, running water, is used, especially for the final rinsing. The quality of anodes has been greatly improved, thereby aiding in producing a whiter metal. The shape of the anode also has received careful consideration and the quality and uniformity of the deposit has been wonderfully improved thereby. The plater has studied and experimented and has discarded the superstitions of the old school. Today there exists only the shadow of that heinous monster—*the plater's secret.* Formulas exist today as in the past, some just as complicated, but the fact, nevertheless, remains that some of our best nickelplating is being done in baths consisting only of the double sulphate. One plater may use single salts to tone up his solution; another obtains the same results by the judicious use of the electric current and carefully avoids a depleted condition of his solution; one plater will drug his solution with sal-ammoniac, sodium chloride or ammonium sulphate to improve the conductivity, while others carefully avoid these chemicals. Boracic acid is used today in large quantities by platers, who a few years ago, scorned the idea. They have either experimented to satisfy their own curiosity or have been compelled to adopt it to obtain the results demanded.

Liquid ammonia, which at one time was used extensively, has at last been recognized as one of the chemicals to be avoided, unless the plater is conversant with its use and reactions in a nickel solution. The use of a four or five-volt current with the old style, flat anodes and concentrated solution, were conducive of many difficulties. Today, 1½ to 2½ volts, anodes of any shape to meet the demands of a particular line of work and a solution maintained at considerably lower specific gravity than formerly, have greatly minimized the complexities of the plating department. Yet there are arising constantly new difficulties to overcome, new problems to solve and to meet them squarely we must be ever on the alert.

Liquid Ammonia

In one respect, the platers of today are deplorably deficient. They are not thorough enough. Our predecessors possessed the same fault and we have not improved greatly. Thoroughness and simplicity should be coupled with cleanliness when considering a problem in the electro-deposition of metals. If we expect to reap the full benefits of our labors we should inquire into the why and wherefore of this and that more deeply. The chemicals used in electro-plating and coloring are particularly susceptible to adulteration and it is generally within the powers of the foreman plater to reject or accept the material used.

Automobile manufacturers now favor the nickel finish and the quantity of work offered equals, and, in some cases, exceeds that handled in the days of the bicycle craze. While the essential points of nickelplating automobile parts is similar to bicycle work, in many ways it is easier of accomplishment. Glass wind shield frames were formerly plated after removing the glass. This entailed extra expense and loss of time. These frames are now plated without removing the glass and are successfully finished by exercising ordinary care. Radiators were regarded a failure seven times out of ten, but today the average plater considers a failure an exception.

The nickel solution which is work-

ing constantly and near its capacity, requires careful attention. If the anodes are not frequently cleaned, attention should be given to the conductivity of the bath and to the maintenance of the solution at a specific gravity of not less than five degrees Baume for rapid heavy deposits. If double salts, sal-ammoniac or ammonium sulphate have been used to increase the conductivity, the nickel will have a dark tone and will not possess a silvery whiteness. Ammonium salts are liable to contain various impurities, particularly when the cheaper ammonium sulphate is used in their manufacture. To avoid this and to produce a close-grained, non-porous, hard deposit, which is beautifully white and tough, use only single salts (sulphate of nickel). For a 300-gallon solution dissolve 20 pounds of the single salts in 10 gallons of hot water. Introduce as much metal into the bath as would be contained in 55 or 60 pounds of double salts free from the impurities. The bath then requires clearing and the conductivity is increased as follows: Two and one-half pints of 26 per cent liquid ammonia is well-stirred into the solution; 15 ounces of C. P. sulphuric acid are added to clear the solution and to take up the ammonia, forming an ammonia salt which increases the conductivity of the solution. After thoroughly stirring the bath it should be allowed to settle, when it is ready for use. This method of procedure insures purity of the chemicals, the results are certain, the expense is no greater than any other methods and the invigorated condition of the bath is apparent upon first trial. The percentage of nickel introduced can be controlled, which is impossible when low grade double salts are used.

Operating the Nickel Bath

In operating this bath and to maintain it in constant working condition it is advisable, though not actually necessary, to use both rolled and cast nickel anodes, the proportion being two cast or possibly three cast to one rolled anode. If, after working the bath some time, it is inclined to become acid, the remedy is the use of more cast anodes. If the bath has a tendency to become alkaline, the number of rolled anodes may be increased to aid the formation of sulphuric acid to neutralize the ammonia. As the specific gravity of rolled nickel is 9.3, and cast nickel 8.3, it naturally follows that the current will attack the cast anode more strongly than the rolled; therefore, better results will be obtained by hanging the rolled anodes toward the ends of the cathode rod, placing the cast anodes near the center. If the anodes have a hard, glazed surface it is advisable to sand blast them or to remove a portion of the outer crust by lightly going over the surface with an emery wheel.

The Anodes

If the density of a nickel bath is kept low the use of rolled anodes usually can be dispensed with entirely; but if the bath is above the usual density and is operated as a still solution, the use of rolled anodes will be found to be a wonderful aid in avoiding the troubles many platers experience in regulating a nickel solution. As the nickel anodes on the market today are cast from 85 per cent pure nickel and 15 per cent alloy to 95 per cent pure nickel and 5 per cent alloy, there is a wide range from which to select an anode best adapted for any particular class of work. The alloy consists of iron and tin, the percentage of iron being the greater. Cobalt is present in very small quantities, as it is a commercial impossibility to eliminate it entirely from the nickel. A portion of the iron is carried over to the cathode and becomes part of the deposit, rendering it whiter than pure nickel. The greater proportion of the iron is precipitated to the bottom of the tank where it accumulates in the form of basic sulphate of iron, the mud or slime being composed of iron, tin, carbon, etc. If at any time the iron in the deposit becomes troublesome, the work can be dipped in dilute muriatic acid after being removed from the bath, rinsed well and dried as usual.

The use of 95 per cent pure nickel anodes in a bath, such as just mentioned or of equal quality, insures the production of a lustrous deposit less liable to tarnish as readily as when obtained in a bath containing anodes with a lower percentage of nickel and operated in an alkaline condition. We believe that the 85 or 87 per cent nickel anode is the direct course of many cases of serious trouble from occluded hydrogen. The iron content, although small, has a tendency to render the deposit very brittle if a great current density is used, as in stove work. If, however, a lower current density is maintained, this is not the case. This applies only to still solutions, as the deposit from agitated solutions is quite free from this defect, the hydrogen gas being removed before doing any harm.

When plating plumbers' hardware or any composition of metals in which tin is used, trouble is often experienced from peeling deposits. We have seen the same results on stove parts when milled or tumbled in a dirty tumbler previously used on blackleaded parts and as oxides formed on the polished surface when immersed in the cleaning bath are only partially removed, the use of cyanide potassium in such cases is of no avail. A 3 to 5 per cent solution of hydrochloric acid in water will remove the oxide very readily and has the advantage of being practically harmless and inexpensive.

Filter Bag

When a nickel solution becomes poor in metal the deposit is quite liable to peel on account of the rapid evolution of hydrogen. Frequently, platers have sought the cause of the trouble elsewhere or have attributed it to other reasons. In plating rooms where the amount of work is constantly kept equal to the capacity of the solutions, every hour counts and many platers operate solutions in a dirty condition under such circumstances, because of a lack of time to filter them properly. When operating at capacity, the following suggestion can be adopted to advantage: Procure sufficient factory cotton to make a bag nearly the size of the tank. This is placed inside of the side rows of anodes and extends 1½ inches above the tank bottom. This bag is tacked to a frame the size of the top of the tank. If three rows of anodes are used remove the center row and place the frame in position, allowing the bag to drop inside of the tank. The center row of anodes is then replaced. Any foreign matter from the anodes will remain outside of the bag and the active portions of the solution will remain clean, being protected by the bag. The rapidity of deposit will not be affected nor will there be any change in the solution, as the bag merely acts as a filter.

Germany's Bronze Powder Industry

Nuremberg is the center of the bronze powder industry of Germany, according to a recent consular report. The annual value of the product is about $3,000,000 and the number of workmen employed aggregate 1,200. The raw materials used in the manufacture of the better grade of bronze powder are copper and zinc. For

THE FOUNDRY DATA SHEET, FEBRUARY, 1912

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

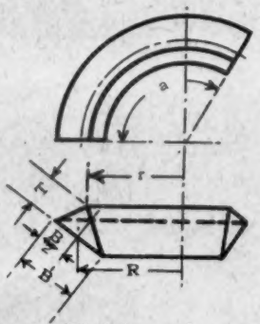
Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form.

FORMULAS FOR FINDING THE WEIGHTS OF IRON CASTINGS

By W. L. Tryon

To find the weight of a segment of a ring of triangular cross-section, multiply the base of the triangle by the altitude, by the sum of twice the radius of the circle described by the center of the base and the radius of the circle described by the vertex of the triangle, by the number of degrees in the angle, by 0.000757.

$$W = BTa\ (2R + r) \times 0.000757$$



W = Weight of casting in pounds.

B = Base of triangle in inches.

T = Altitude of triangle in inches.

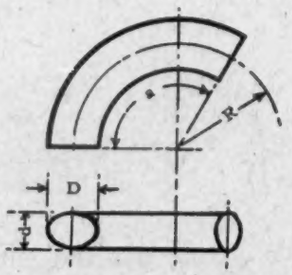
R = Radius of circle described by center of the base of the triangle in inches.

r = Radius of circle, described by vertex of triangle in inches.

a = number of degrees in the angle.

To find the weight of a segment of a ring of elliptical cross-section, multiply the radius of the circle passing through the center of the cross-section by the large diameter of the ellipse, by the small diameter, by the number of degrees in the angle, by 0.00357.

$$W = RDda \times 0.00357$$



W = Weight of casting in pounds.

R = Radius of the circle passing through the center of the cross-section in inches.

D = Large diameter of ellipse in inches.

d = Small diameter of ellipse in inches.

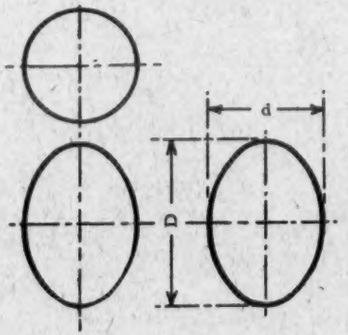
a = Number of degrees in the angle.

FORMULAS FOR FINDING THE WEIGHTS OF IRON CASTINGS

By W. L. Tryon

To find the weight of an ellipsoid, multiply the square of the revolving axis by the fixed axis, by 0.136.

$$W = Dd^2 \times 0.136$$



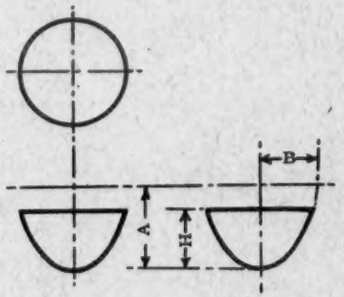
W = Weight of casting in pounds.

D = Fixed axis of ellipsoid in inches.

d = Revolving axis of ellipsoid in inches.

To find the weight of a segment of an ellipsoid when the base is parallel to the revolving axis, multiply the difference between three times the fixed semi-axis and the height of the segment by the square of the height, by the square of the revolving semi-axis, by 0.272 and divide by the square of the fixed semi-axis.

$$W = \frac{(3A - H)\ H^2B^2 \times 0.272}{A^2}$$



W = Weight of casting in pounds.

A = Fixed semi-axis of ellipsoid in inches.

B = Revolving semi-axis of ellipsoid in inches.

H = Height of segment in inches.

cheaper grades, various kinds of metal scraps, from the toy and other factories, are mixed with these two basic metals. The alloy, which is merely brass, is made in graphite crucibles, and is run into ingots about ⅝ inch thick and 12 inches long. The ingots are flattened by power hammers and are rolled under great pressure until they are extended into metal ribbons. While undergoing these operations the metal is annealed in wood-fired furnaces to overcome brittleness, and after being rolled, is cut into strips about two yards long. These strips are bundled and are subjected again to the hammering process. This is followed by another annealing, after which the bundles are hammered again. The metal in the form of thin sheets, is tied into large bundles and once more is beaten under the hammer. When the required thinness is obtained the sheets are cut and torn into shreds, and are placed into hermetically-sealed iron boxes, in which they are pounded into a powder by vertical stamps. The material is passed from one mill to another until reduced to the fine metallic flour known as bronze powder.

Troubles of the Electro Plater

Acid Baths

We have a 300-gallon acid copper solution which is causing our plater much trouble. The work is streaked and is often sandy or coarse-grained and does not adhere.

Acid copper baths have a tendency to become acid when continually used; therefore, use a large anode surface and a low voltage, about one volt or less. The streaks are caused by too strong a current, which also burns the deposit, rendering it sandy and iron adherent. Keep the amount of free acid small in the bath by removing a part of the solution and adding water; then hang it in bags containing copper sulphate, allowing it to remain over night. This will increase the metallic strength. If the work is of irregular shape or has projections, one per cent of free acid is sufficient; if the work is flat, as high as five per cent can be used safely.

Aluminum Alloy and Die-Casting

We manufacture an aluminum article cast in sand which contains 80 parts aluminum, 17 1/2 parts zinc and 2 1/2 parts copper. It requires seven operations to finish it, some of which are quite expensive. We have been informed that six of these operations can be performed in one by die-casting the piece and the polishing effected by tumbling in steel balls. Can you advise us whether this can be done successfully?

This aluminum alloy cannot be die-cast owing to its high shrinkage. If you can use an alloy suitable for die-casting, although somewhat heavier, you can undoubtedly reduce the number of operations. Possibly a compensating die could be utilized. As you do not mention what the operations consist of we cannot say whether all could be dispensed with. Many very intricate designs are die-cast and in some cases the work is really more perfect than the machined article. The alloy you are using can be burnished with steel balls, thereby saving the polishing expense. We advise you to investigate the idea, as perhaps a slight change in the alloy would solve your problem.

Nile Green Finish

We want a pale green finish for vase holders and speaking tubes used in equipping limousine automobile bodies. Our upholstering is done in Nile green leather.

To match your leather, finish the metal parts in antique Nile green brass, as follows: Polish the brass and then go over it with either a brass scratch brush or a tampico brush and pumice. This produces a brush brass finish. Wash well and have ready a hot solution consisting of sulphate of copper, 4 ounces, and sulphate of iron, 4 ounces, for each gallon of water. Immerse the articles in this solution. The green first appearing will be an olive shade, but by agitating the work in the dip, the Nile green will appear rapidly. After color is obtained, remove and rinse. On the vases, try silvering the high parts, then lacquer with a good strong lacquer.

Pitting of Nickel Deposits

Recently we cleaned our nickel solution by straining and cleaned the slime from the bottom of the tank. After replacing the solution, we filled the tank with water. The solution has since caused pin holes on the work. Please give the cause of this trouble and the remedy.

After cleaning a nickel solution it is a good plan to operate the solution on light loads for a few batches and instead of filling with water, add a solution of double sulphate of nickel and ammonia. The pitting of nickel deposits generally is caused by a depleted condition of the solution or an excess of acid. In either case an excess of hydrogen gas is produced upon the work, each gas bubble causing a pin hole. If you are satisfied that the solution is not too acid, add 3 ounces single salts to each gallon; if it is too acid, 1 ounce of carbonate of nickel added to each gallon of solution will aid in taking up some of the acid. Perhaps more of the carbonate will be required. However, after a trial you will be able to judge. Keep plenty of metal in the solution and avoid an excess of acid and pitting will not occur.

Dip for Gold Tint

I have heard of a mixture used in brass solutions that will produce a gold tint or at least a bright yellow tone to the deposit without the use of arsenic. Will you kindly publish such a formula?

The following mixture will produce the results you desire and is more pronounced in baths using brass anodes, but can be used with copper anodes with good results: Dissolve 4 pounds of powdered bisulphite of soda; 4 pounds of sulphate of iron crystals and 2 pounds ammonium chloride in 5 gallons of water; stir well and add enough cyanide of potassium to produce a clear solution. Boil this for 30 or 40 minutes, allow to cool and place in large bottles or jars. When using this mixture add 1½ ounces to each gallon of brass solution. We do not advise the use of this formula in a brass solution containing arsenic or white stick caustic potash.

Matte-Finishing

Can you inform us of a quick method of matte-finishing small brass goods, something easy to operate and inexpensive?

The matte acid dip will answer your purpose nicely. Make a dip of metallic zinc, 6 ounces; nitric acid, one gallon, and oil of vitriol, one gallon. Dissolve the zinc in the nitric acid, then add the oil of vitriol. Use the dip warm and agitate it while in use to procure the best results. If the matte is too fine, add nitric acid; if too coarse, add oil of vitriol. A one minute immersion should suffice. If a little slow at first, add a small amount of muriatic acid. After obtaining the matte wash, bright acid dip and plate.

Blue Black Finish

We have been trying to obtain a durable blue black finish on some silver ornamental goods. Thus far our efforts have failed us. Can you tell us how to proceed?

The following will prove sufficiently durable on silver for all ornamental purposes: Double nickel salts, 4 ounces; liver of sulphur, 4 ounces; hyposulphite of soda, 2 ounces, and water, 1 gallon. Use this as a dip and then lacquer the articles. This finish can be scratch-brushed or color-buffed and is used extensively.

Mock Iron Mixture

Recently, while taking stock, we discovered a large quantity of iron castings which had been rejected because of large sand holes. As they have been machined we would like to save them. Can you furnish us with the formula for the co-called mock iron mixture?

The mock iron mixture you mention can be used if you enlarge the base of the holes, so they taper toward the opening. The mixture expands in cooling. It is made as follows: Lead, 9 parts; bismuth, 1 part, and antimony, 2 parts.

New Electroplating Processes

Some remarkable results of the electroplating process were exhibited recently by the Harvey Electro-Chemical Co., London, Eng. Porcelain, glass and earthen ware plated with silver, gold, copper and nickel attracted great attention. The difficulty of plating aluminum has been overcome successfully by this company, and aluminum tubes coated with copper, zinc and brass were exhibited. Aluminum protected in this way resists the action of sea water and can be soldered. These various processes of coating metals are the invention of Quentin Marino, of Brussels, a son of Prof. Pascal Marino, of Naples.

Several distinct processes are involved in these various electroplating methods and in the case of china and glass, the surface must be made rough by sand-blasting, grinding or etching. For glazed surfaces, mechanical treatment is first necessary, but in the case of porcelain or earthen ware, etching with hydrofluoric acid can be resorted to. The acid used contains some salt of the metal that is to be deposited, such, for instance, as copper and silver. Sometimes both these metals are used, silver nitrate being precipitated with copper oxide and the precipitate, a complex compound, is dissolved in hydrofluoric acid. This solution is applied to the object and the metal or two metals are then reprecipitated upon the object so as to form a molecular coating that will adhere to the surface. This is accomplished by two different methods: Either the surface is dusted with a powdered metal, usually zinc or copper, which will reduce the metal contained in the fluoride, or the moist surface to which the acid has been applied is pressed against a revolving brush consisting of very fine zinc, copper or brass wires. When practicing the first method the metallic powder is rubbed into the surface and the excess is afterward brushed off. When using the revolving brush the fine metallic hairs come into contact with every point of the surface of the prepared object and their tips form local couples with the metal dissolved in the acid, causing it to be deposited upon the glass or earthen surface. The treated object is then suspended from the cathode in an ordinary plating solution. When metallic initials or ornaments are to be produced on porcelain or glass, the pattern is etched into the ware mechanically or by acid. The coatings adhere firmly and the deposits cannot be peeled off. Thick metal rims have heretofore been attached to glass and china by plaster of paris or other compounds. By the Marino process, rims of any thickness may be deposited. In plating aluminum with other metals ,the articles are first pickled in hydrofluoric acid, after which excellent deposits of copper, brass and tin are obtained.

Aluminum is deposited on iron or brass from a neutral bath that contains no inorganic acid. A two-volt current is used. Zinc is also deposited from a neutral bath and the coated surface is smooth. The articles are washed first in caustic potash, then in dilute hydrochloric acid, and are rinsed in water. The articles then are immersed in the plating bath, where they are coated with zinc. The anodes in alloy deposition, as in other processes, may consist of the alloy or one of the metals only, the other metals being contained in the bath.

Cast Iron for Copper-Plating

By W. J. Keep

Question:—Is there any particular iron mixture especially adapted for castings that are to be copper-plated? When polished, our castings develop spots which result in their rejection.

Answer:—The thickness of the castings will largely regulate the necessary iron mixture. If the castings to be plated are about ⅛ inch thick the iron should be very fluid and the silicon content should be approximately 3 per cent; phosphorus, 1 per cent and the pig iron used should be close-grained. If this grade of iron is not obtainable, considerable scrap should be added to the mixture. The iron should be melted hot. If the percentage of pig iron in your mixture is too high and if there is an insufficient amount of scrap, the graphitic carbon content of the casting will be too high. It is not absolutely essential to pour the metal hot, but it is necessary to melt it hot. As a temporary relief, add a piece of aluminum ¾ inch long cut from a ⅜ inch rod, to every 50-pound ladle of iron. A change in the method of gating frequently will prevent the spots to which you refer. The casting should solidify as soon as the mold is filled to prevent the separation of graphite.

If you are tapping two grades of iron from the same heat, one soft and the other hard, the soft iron should be tapped out at the beginning of the heat, or if you prefer, you can add sufficient 50-per cent ferro-silicon to the iron in the ladle to increase the silicon content of the soft iron from 2.75 to 3 per cent. You can use ferro-silicon in place of aluminum. The analysis of your mixture is satisfactory for your work, provided the grain of the iron is sufficiently close.

In a four-page folder, the Midland Machine Co., Detroit, manufacturer of molding machines, illustrates the Grimes jolt-ramming roll-over core machine, roll-over molding machine and a stripping or drop plate machine.

Manufacture of Malleable Iron Stove Plate

A Description of the Methods Pursued in the Production of These Castings in a Wisconsin Foundry

THE Malleable Iron Range Co., Beaver Dam, Wis., operates a large and completely equipped plant, devoted exclusively to the production of malleable ranges. The works consist of malleable and gray iron foundries and buildings and equipment for assembling the ranges. The malleable foundry is one of the most interesting features of the plant, since the problems that confront it are unusual and have been solved in an original manner, and from the further fact that the Malleable Iron Range Co. is said to be the only manufacturer of malleable ranges owning and operating a malleable foundry for the exclusive production of stove castings.

The difficulties in economically operating such a shop can be appreciated. The castings are light in weight; the percentage of sprues and loss has always been very high; a great many molds must be made daily, involving the handling of a large number of flasks and many cubic feet of sand; the floor space required is large and the necessary equipment is expensive; many men must be employed, and for all this outlay in plant, materials and labor the tonnage of good castings produced has been relatively small and the cost correspondingly high. Most stove manufacturers have sought to escape from this dilemma by buying their malleable castings from some plant making a specialty of jobbing work. But this method of solving the problem also has its disadvantages. The stove manufacturer has no direct control over the quality of the castings and there is at times trouble with deliveries due to freight congestion or other causes that cannot be prevented. Also, the foundry is such an intimate part of any stove plant, that it is to the manufacturer's advantage to have it directly under his control in all departments.

Malleable Foundry Difficulties

After some years' experience in buying its malleable castings from outside shops, the Malleable Iron Range Co. concluded that the best interests of its business demanded that it build and operate a malleable foundry of its own. The difficulties in the way of this policy have been surmounted by operating the malleable shop in close union with the gray iron foundry, using the same gang of laborers for both, thus materially reducing the labor cost per ton in each department and particularly in the malleable foundry. Also, a special study of the details of molding and casting has been made in the malleable foundry with the aim of reducing to a minimum the losses due to bad castings and the waste metal involved in sprues and gates. Up to the present time these losses have been reduced from 25 per cent, which is considered good practice in some shops making malleable stove plate, to less than 10 per cent and it is expected that the loss will eventually be brought down to 5 per cent or less. A great many patterns have been remounted so as to cut down the waste in sprues and gates; many castings which, heretofore, were made with two sprues are now poured with one, reducing the weight of waste metal from 30 to 50 per cent.

The foundry building is L-shaped, as shown in Fig. 10, the gray iron shop occupying one branch and the malleable department the other. The axes of the two branches meet at an acute angle to conform to the property lines. The gray iron shop is 155 feet long and 70 feet wide; the malleable foundry is 190 feet long and 70 feet wide, exclusive of the annealing room, which is 60 x 90 feet. The mill room, located between the annealing room and main foundry, is 90 feet long and 15 feet wide.

The building is steel frame con-

FIG. 1—A GENERAL VIEW OF THE MALLEABLE FOUNDRY, SHOWING THE AIR FURNACE IN THE CENTER

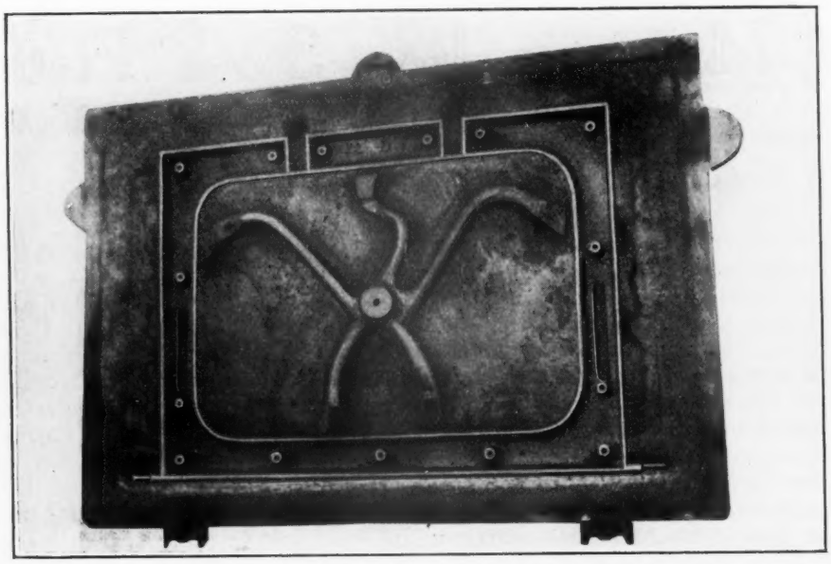


FIG. 2—COPE SIDE OF OVEN DOOR MATCH-PLATE, SHOWING THE S-GATE

struction with brick walls stiffened by pilasters. The monitor, in addition to the usual ventilating windows, is supplied with a row of inclined sash 5 feet wide, which greatly improves the light in the building. Four 12-inch ventilators are fitted to each monitor. The roof consists of 2-inch plank laid on the upper chords of the trusses and is covered with a roofing material. Artificial illumination is supplied by a row of 250-watt tungsten units spaced 60 feet apart down the center aisle of each shop, supplemented by incandescent lamps at the sides over the molding machines and wherever necessary. Each shop is heated by parallel pipe coils suspended from the roof trusses, as shown in Fig. 1. Exhaust steam circulates through the coils, but in severe weather live steam is used if necessary. In the malleable shop there are eight coils, six having 417 square feet of radiation surface each and two 365 square feet, making the total radiation 3,232 square feet. In the gray iron foundry there are 2,607 square feet of radiation divided into seven coils. The buildings are equipped with automatic sprinklers throughout.

Melting Malleable Iron

Metal is melted in the malleable foundry by a 10-ton, coal-fired air furnace, Fig. 6, built by the Whiting Foundry Equipment Co., Harvey, Ill. The furnace is standard in construction, but attention should be directed to the extra heavy cast iron plates and brackets which serve as binding on the sides and end, the end plates being ribbed. The gases from the furnace, before passing up the stack, are

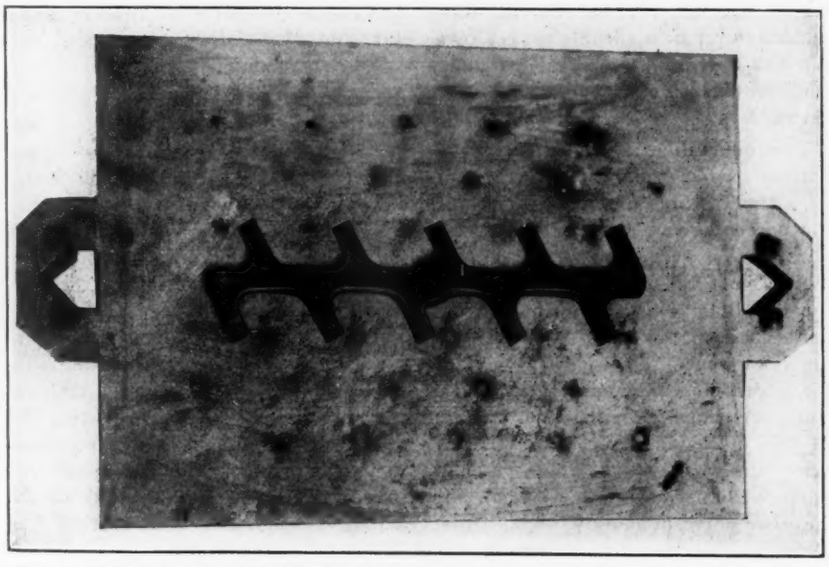


FIG. 4.—COPE SIDE OF MATCH-PLATE, SHOWING METHOD OF GATING SMALL CASTINGS

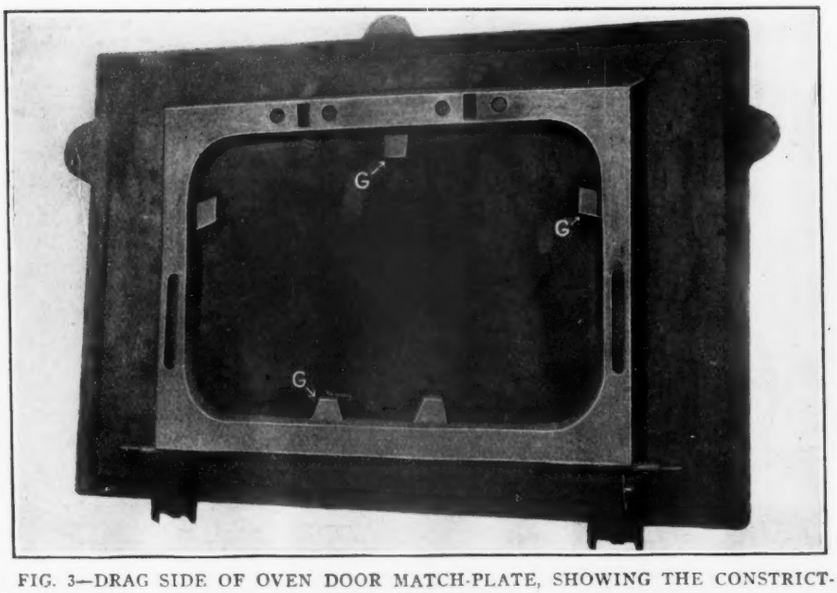


FIG. 3—DRAG SIDE OF OVEN DOOR MATCH-PLATE, SHOWING THE CONSTRICTED GATES AT *G*

led through a 300-horsepower Wickes vertical waste heat boiler, which supplies sufficient steam to take care of the power requirements of the entire plant. The use of this boiler saves at least five tons of coal per day. The furnace practice is standard. The silica sand for the bottom is obtained from Portage, Wis., a few miles from Beaver Dam. A new bottom is made every week and every two weeks the side walls are repaired. No southern pig iron is used, it being more economical to melt northern iron, most of which comes from the Mayville furnaces of the Northwestern Iron Co., which are situated only 25 miles from Beaver Dam. While the air furnace is nominally rated at 10 tons, the heats vary from 6 to 14 tons, according to requirements. The fuel ratio is about 42 per cent and it

requires five hours to melt down a normal heat and three hours and 20 minutes to handle a 6½-ton heat. In the table on the following page is given a mixture used for a typical heat of 6½ tons.

The net area of the molding floor in the malleable shop is 8,400 square feet, thus giving 420 square feet of floor space per ton of output daily, assuming two daily heats of 10 tons each. A large portion of the molding is done on Arcade vibrator machines and Arcade squeezers, there being 37 of the former and 12 of the latter in the shop. These machines are arranged along the walls, as indicated in Figs. 1 and 8. Some of the heavier work is done on the floor, using hinged match plates, although as fast as possible arrangements are being made to handle all of the work on the

FIG. 6—THE 10-TON AIR FURNACE

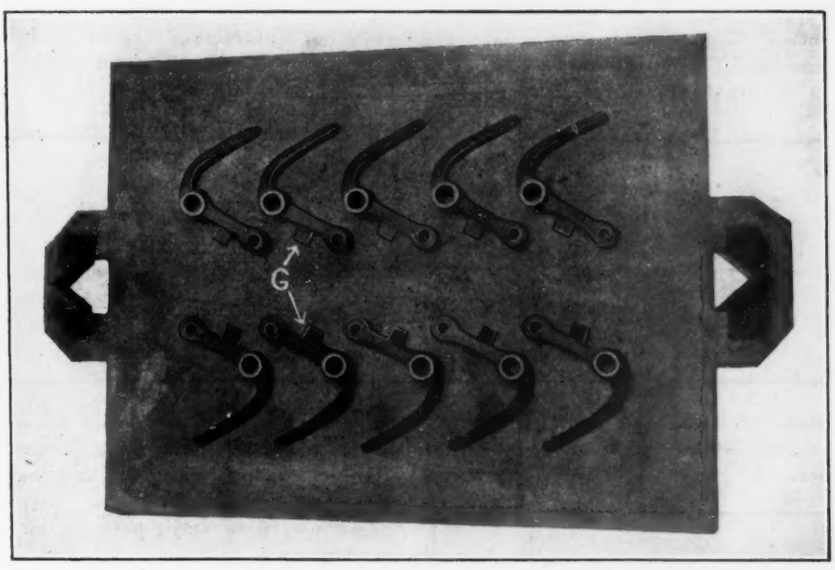


FIG. 5—DAMPER ARM PATTERNS ON DRAG SIDE OF ALUMINUM MATCH-PLATE; THE GATES ARE SHOWN AT *G*

machines. About 60 molders are employed.

Fig. 9 shows one of the molds which are now made on the floor. This is a collar top, being that portion of the stove provided with an elliptical collar on which the pipe is fitted. Two of these castings are molded in each flask. As shown in the illustration, there are only two sprues, whereas before the patterns were remounted there were four. The flasks are 18 x 36 inches and one man puts up about 40 molds per day. The flask and match-plate hinges are a modification of the Bucks hinge. The principal features of this improved hinge are shown in Figs. 3 and 9. It will be noted that whereas the Bucks hinge is rigid in one direction only and has to be fitted individually to each flask, this hinge is rigid in both directions and absolutely prevents the cope and drag from getting out of register. The hinge works on the knife edge principle, which is so successfully employed in fine instrument making, where accurate motions are necessary.

It will be noted from Fig. 9 that the flasks have wooden sides and cast iron ends, with handles cast with the ends. Attention is directed also to the tongue, *T*, on the match-plate. This is known as the rapping tongue, it being the only portion of the plate which is exposed when the flask is closed.

Stove lids are molded on a machine, two lids in each flask. In order to insure the lids being smooth and not injured by dirt carried into the mold by the flowing metal, the mold is slicked with plumbago under the gate

FIG. 7—A VIEW OF THE GRINDING ROOM

FIG. 8—A FLOOR READY FOR POURING, SHOWING LARGE MOLDS WITH ONE GATE

impressions where the errosion is greatest. One man with a machine puts up 160 of these molds in a day.

Figs. 2, 3, 4 and 5 show both sides of two of the special aluminum match-plates, which are used very extensively in this shop. The plate shown in Figs. 2 and 3 contains an oven door pattern and that illustrated in Figs. 4 and 5 contains several patterns of damper regulating arms. These plates have a number of features of special interest.

Oven Door Match-Plate

The oven door match-plate, Fig. 2, shows clearly a type of gate known as the S-gate, which has been developed in this shop in order to avoid breaking the sprues while hot and to insure clean castings and reduce the number of runners. It is customary in malleable foundries casting stove plate to break the sprues from the casting while the metal is still red hot. If the sprues are not broken off until the castings cool, considerable loss results on account of the brittle nature of the metal before it is annealed. The S-gate does away with all hot breaks, thereby avoiding heavy losses. It will be noted that the gates are confined almost entirely in the cope, only the very ends of the gate prints appearing on the drag side of the plate, Fig. 3, on which the pattern is mounted. The metal, therefore, in flowing through the gates moves constantly on a down grade and is not so inclined to tear out the sand, since it flows by gravity as much as by the pressure due to the molten metal in the runner. It will be noted that the gate is greatly restricted at the point where it enters the mold. This neck or orifice is made as small as possible and just back of the orifice the gate is greatly enlarged. When this gate cools the resulting contraction breaks it from the casting, or if the strain produced in cooling is not sufficient to accomplish this, the gate is easily broken off by a light blow from a hammer after the casting has cooled and there is no danger of injuring it. Fig. 5 shows a card of small patterns on a match-plate.

Mixture for a Typical 6½-ton Heat of Malleable Iron.

Weight, pounds.	Material.	Analysis— Silicon, per cent.	Sulphur, per cent.	Phosphorus, per cent.	Manganese, per cent.
2 200	Pig iron	1.50	0.020	0.160	0.51
510	Pig iron	1.69	0.031	0.180	0.56
1.100	Charcoal pig	1.66	0.015	0.150	0.61
915	Charcoal pig	1.51	0.018	0.145	0.48
2,100	Pig iron	1.03	0.024	0.182	0.57
400	Annealed-scrap	0.98	0.070	0.167	0.31
400	Steel rails	0.30	.....	.....	0.70
5,600	Sprues and gates	0.98	0.061	0.167	0.31

FIG. 9—COLLAR TOP MOLD, SHOWING METHOD OF GATING

Match-Plate Mixture

The match-plates are cast aluminum of the following composition: Six parts aluminum, one part zinc and one-half part bismuth. The aluminum and zinc are melted together first and the bismuth is added to the molten mixture. The plates are cast in skin dried molds. The patterns, gate prints, etc., are made from a pattern brass of the following composition: Seventeen pounds of copper, one pound of tin, five pounds of sheet copper scrap and one-half ounce of bismuth. The patterns, etc., are mounted on the plates by machine screws with counter-sunk heads, the screw-heads being filled with solder.

Two heats are generally poured each day and laborers are employed to shake-out the flasks and clean-up the floors and gangways. The molders cut over their own sand with the assistance of a laborer if necessary.

The same gang of laborers for the malleable shop is also employed in the gray iron foundry. When the malleable shop was built a 24-inch industrial track extended through the center, connecting the molding floor with the cleaning room and the finished castings were carried to the cleaning room in trucks running on this track. It was found, however, that considerable loss was suffered through the breakage of light castings handled in quantities by this method and the track was removed. At the present time the castings are conveyed to the cleaning and annealing room a few at a time in wheelbarrows and although the labor cost is undoubtedly higher than it was when the track was in service, the gain due to the reduction in breakages more than balances the increased expenses, resulting in a net saving.

Most of the molds have only a thin wall of sand and to avoid runouts from snap-flask work, the molds are jacketed while they are poured. Only about a half dozen jackets and weights are used on each floor, a laborer being employed to shift them while the molder is pouring.

As shown in Fig. 10, the cleaning room is located between the molding room and annealing room. There are 10 mills, five for cleaning hot castings and five for handling annealed work. They are all driven through shafts and belts by a 20-horsepower, 220-volt, 3-phase, 60-cycle motor. Five of the mills, which are 26 inches in diameter and 60 inches long, are used for cleaning annealed castings, and three of the same size clean the hard castings. In addition, the small hard castings are tumbled in two square 8-foot x 24-inch mills.

Annealing Ovens

There are four annealing ovens arranged in a row and fired with coal at the rear. These ovens were furnished by the Whiting Foundry Equipment Co., Harvey, Ill., and are each 18 feet long, 12 feet wide and 9 feet high, with a capacity of 32 pots each. The standard pots are 24 x 30 inches, 13 inches deep, cast in one piece 1 inch thick. Malleable iron pots are used and have been found much more durable than ordinary gray iron pots, lasting from 20 to 30 heats. The castings are packed in mill scale and are annealed about 72 hours. Occasionally, coke siftings are used with the mill scale. The pots are designed so that the castings will fit snugly in order to get the maximum tonnage in each heat. A 30-foot span, 4-ton Whiting traveling crane extends in front of the ovens and is used for handling doors, pots, etc. After the castings are annealed and cleaned they are taken to the factory building on the industrial railway, where they are first straightened under heavy drop hammers and later polished and ground.

Gray Iron Foundry

The gray iron foundry presents no unusual features. It is equipped with a Whiting cupola, 36 inches in diameter inside of lining, located as indicated in Fig. 10. Only light work is produced, so no traveling or jib cranes are employed. The 24-inch industrial railway which connects the various departments of the plant and the yard extends down the center of the gray iron shop for conveniently handling materials. The castings are machine-molded, using match-plates similar to those described for the malleable work. Facing sand, consisting of one pound of bolted sea coal mixed with ten to twelve pounds of molding sand, is used for molds for light ornamental castings.

The core room is situated in the corner at the junction of the gray iron and malleable shops, as shown in Fig. 10. Very few dry sand cores are used and they are all light and simple in character. The core room is equipped with a Whiting shelf oven.

Both shops are provided with compressed air. The steam is generated in a waste heat boiler connected with the air furnace. The engines and generators are located adjacent to the range factory some distance from the foundry. The engine room equipment includes a 225-horsepower, Fitchburg engine connected to the machinery in the factory, through a system of rope drives and a 240-volt, 48-ampere, 3-phase direct-connected unit, recently installed. An Ingersoll-Rand air compressor is also included in the equipment.

The officers of the Malleable Iron Range Co. are as follows: A. G. Hill, president; Fred W. Rogers, vice president, and Silas McClure, secretary.

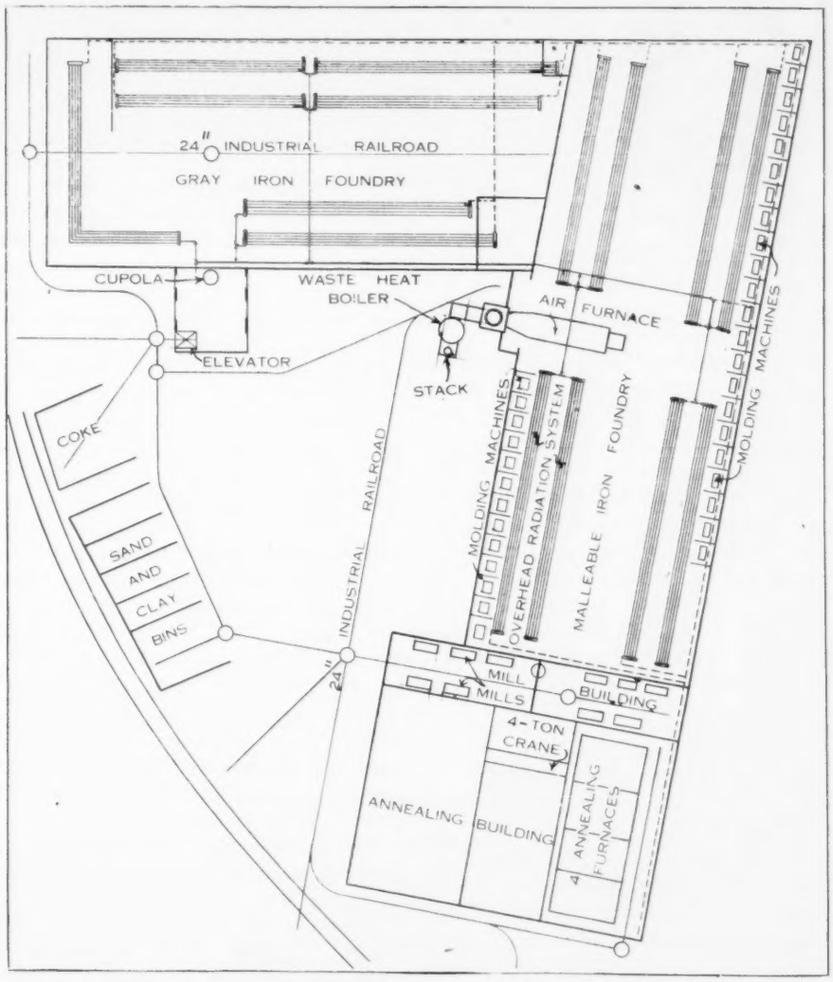
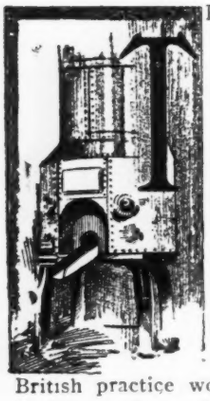


FIG. 10—GENERAL LAYOUT OF THE MALLEABLE IRON RANGE CO.'S GRAY IRON AND MALLEABLE FOUNDRY

Pertinent Suggestions for Cupola Operators*

A Discussion of Furnace Charging, Fuel Ratios, Fluxing, the Action of Slags and the Melting of Steel

By P Munnoch



THERE is no intention in this paper to touch on all the various phases of cupola practice or cupola equipment. Some of these will be lightly dealt with and a few points will be more fully considered. It has been suggested that some ideas of British practice would be of interest. Owing to the varied conditions under which the British foundrymen labor, it is difficult to generalize.

As regards the cupola in some of the smaller foundries, there are a few of the old relics bequeathed by a past generation. There are others which vary in construction, up to the best examples of modern engineering practice. Sizes vary, and internal diameters, when lined, may run up to 60 or 72 inches in the foundry. In the steel works there seems to be no limit to size and melting capacity, as some are capable of turning out as much or more metal than an average blast furnace.

Duration of Blow

As regards duration of blow, the steelworks have no difficulty in running the cupola continuously throughout the week. At many foundries we find the cupola melting iron from starting time in the morning until stopping time at night. In some cases, blast is stopped at meal hours; in other cases the cupolas run through without a stop. There are foundries where the cupola runs for two or three hours during the morning and is then blown down and allowed to drain. In the afternoon coke is added to replenish the bed and the furnace is filled up and run for two or three hours during the afternoon.

These methods are in use where large quantities of castings are required of one type, or for which similar metal may be used. Where several mixtures are melted in the same cupola, they are usually separated in the ordinary manner, by the addition of a blank charge of coke.

Continuous melting is usually employed in foundries where floor space is limited and large outputs are obtained either by casting the work at frequent intervals during the day or in other cases by continuous molding and pouring.

Charging Equipment

Charging appliances are in use at the steel works where cupola melting is practiced, but this method has not met with extended use in the foundry. The crane and box type of charging is chiefly used in steel works, but the tilting wagon and side chute is the more usual type used in the foundry. The advantage of mechanical charging over hand charging is most apparent with large cupolas and continuous melting, and some discussion as to the advantage and disadvantage of the various types of mechanical charging apparatus would be welcome.

Blowers of the positive type predominate; fans, however, are used to some extent. Seeing that the turbine blower is being used for blast furnace work, it will, no doubt, be made in suitable type and size for foundry work, if not already in use. Blast pressures vary considerably, but probably average between 12 and 16 ounces.

The weighing of all materials of the charge is rigidly observed in some cases, in others there is partial weighing and in still other cases materials are not weighed at all. In the latter case, pig is charged by the number of pieces, scrap by the number of shovelfuls and coke usually measured in baskets or riddles. Generally, coke is measured rather than weighed out for the separate charges. The charges are usually small and uniform in weight throughout the melt, but there are exceptions to this.

The Charges

In the iron-making districts, pig constitutes a large proportion of the charge and, contrary to the ideas of some foundrymen, severe tests are met using pig iron alone. In some of these districts the bulk of the miscellaneous scrap is used up in basic open-hearth furnaces for the production of steel. In districts removed from the blast furnaces, scrap is used to a much greater extent in the cupola.

Where metal is taken for small castings, bull ladles are often used and the iron allowed to flow continuously, only stopping-up the tap hole when absolutely necessary. Various kinds of tilting spouts are used, also double tilting spouts to fill two ladles alternately from one cupola. Receivers or forehearths are used with some types of cupolas, but these are not extensively employed.

Flux used is chiefly limestone, fluorspar being used in some cases as an addition. The quantity of flux used varies considerably. Some regulate it by the amount of coke used, but generally a certain number of pounds are added per ton of metal charged, the general practice being to use it too sparingly.

Oxidation During Melting

There are two effects which result from oxidation, one of which is the reduction in the amount of silicon and manganese during melting, and the other is the oxidation of the iron. More or less oxidation of iron always takes place, but the resulting metal is usually more or less free from oxide of iron and its effects. Often materials in the charge as steel, oxidized scrap, or even pig irons, receive the blame of causing the effects which are due to oxidation. In other cases or under other conditions, good, clean metal, free from these defects, is obtained from the same materials. It, therefore, appears to depend largely upon conditions of melting. Dr. Moldenke has pointed out that the method of using large charges in the cupola is the chief cause of this trouble, and by reducing the size of the charges and, therefore, preventing any great variation in the height of the coke bed above the tuyeres, this oxidation is prevented. The term large or small charge is rather indefinite; therefore, it is desirable to have some standard for comparison. It might be defined in pounds of iron per square foot of cross-sectional area

*Presented before the American Foundrymen's Association.

of the cupola, measured inside the lining. A charge less than 200 pounds per square foot of cross-sectional area might be considered a small or suitable charge and above this amount a large charge. As it is the coke which requires consideration there would still be some difference due to high or low melting ratios; this applies also in the case of dense, heavy cokes as compared with light porous cokes. Therefore, the lower the melting ratio and the lower the density of the coke, the smaller the charge desirable. Therefore, in some cases, 100 pounds per square foot sectional area might be ample.

Coke Ratio

The coke ratio in melting varies considerably and results are often difficult to compare as in some cases the coke used for the bed is included and in other cases left out of the calculation.

The total coke ratio is obtained from total iron melted compared with total coke used; this is necessary when figuring costs. The coke melting ratio is obtained by comparing the average amount of iron per charge with the average amount of coke per charge. This is most useful for comparing results under varying conditions, as it is not affected by the coke used for the bed. Coke melting ratios vary from about 7 to 1 to 14 to 1 with 10 to 1 as an average figure.

The rate of melting varies considerably, due partly to differences in tuyere area, blast pressure, the nature of materials of charge, whether dense or open, and upon the coke melting ratio. A convenient method of comparing is to take coke burned per unit of time or iron melted per unit of time. In the blast furnace about 3½ pounds of coke per square foot of hearth area per minute is considered an average figure, but only about 2½ pounds of this reaches the hearth and is burnt by the blast. For cupolas about 2½ pounds per minute per square foot of cross-sectional area is a good rate of working, results being often considerably less. The area of cross-section multiplied by 2½ and the result multiplied by 60 (minutes) gives ideal coke consumption per hour. This multiplied by 10 gives ideal rate of melting in pounds of iron per hour, or multiplied by actual coke melting ratio, gives rate of melting which might be expected under good conditions. These figures are useful for making comparisons with the actual melting rate.

Changes during melting are of a more or less stereotyped kind, such as the decrease by about 0.25 per cent of silicon and a reduction of manganese by about one-fourth of the amount present, whether this is 2 per cent or only 0.2 per cent. While these apply in a general way, still, in particular instances we find that conditions have considerable influence; this is especially noticeable with sulphur. When melting all pig charges containing 1.2 to 1.4 per cent of manganese a decrease in the amount of sulphur of about 0.02 to 0.04 per cent is usually noted. Melting pig and scrap mixtures containing about the same amount of manganese usually result in an increase of 0.02 to 0.04 per cent of sulphur. The scrap consists of gates and runners from small castings and constitutes about 50 per cent of the charge.

Borings, when added loose or in wooden boxes, usually result in an increased absorption of sulphur. In some experiments using about 14 per cent of loose borings in the charge, the increase in sulphur was about 0.06 per cent although about 1 per cent of manganese was present. An experiment was tried melting borings alone by charging small amounts in the cupola after blowing down. The resulting metal contained about 0.3 per cent of sulphur, although the borings only contained 0.06 per cent.

In melting good, clean steel scrap with iron, the amount of sulphur taken up is much the same as when the charge is all cast iron. The amount of sulphur in the coke has a great influence on the resulting sulphur content of the melted iron. At a foundry where low sulphur iron was a necessity, an attempt was made to use coke containing 4 per cent of sulphur which had been bought cheap in place of the ordinary coke employed which ran about 0.4 per cent sulphur. In some cases it was used in the bed alone; in others, it was mixed with good coke, and for a short time was used alone. The sulphur increased in the iron from the usual 0.06 per cent to as high as 0.2 and 0.3 per cent and small castings required soft and gray, were hard and white.

In melting steel and iron mixtures the resulting metal usually contains more carbon than the mixture used. This, of course, is due to the steel absorbing carbon while passing through the cupola. When melting steel alone the result is usually a cast iron containing about 2 per cent or more of carbon, which makes it impossible to melt steel in the cupola and obtain from it a steel suitable for the uses for which ordinary steel is employed.

Although limestone is the usual flux for the cupola, other materials are sometimes used. A founder complained to the blast furnace operators, who supplied him with pig iron, that the iron was giving bad results. On investigation, it was found that he was using blast furnace slag as a flux instead of limestone. The slag contained about 2 per cent sulphur. As the castings made from the iron were small, there was sufficient sulphur taken up to change the castings from gray to white.

Low sulphur materials are a necessity when low sulphur castings are required, but there are cases where some increase in sulphur is not objectionable and then a higher content of sulphur may be permitted in metal or coke.

When iron is melted in the cupola without the addition of a flux, the slags formed are chiefly silicates of iron, manganese and alumina. With the addition of lime, silicate of lime is formed and the slag becomes more refractory as the lime increases, due to some extent to the lime replacing the more fusible iron and manganese oxides. The object of adding lime may be either to flux away the excess of siliceous matter, such as coke ash,

Melting Capacities of Cupolas From 24 to 96 Inches Diameter Inside the Lining.

Diameter inside lining Ft. Ins.	Area in square feet.	Coke. At 2½ pounds per square foot per minute.	Coke. 150 pounds per square foot per hour.	Iron. Melted at 10-1 ratio. Pounds per hour.	Iron. Melted at 10-1 ratio. Long tons per hour	Charge of iron at 200 pounds; pounds per square foot area.
2—0	3.14	7.85	0.471	4,710	2.10	628
2—6	4.90	12.25	0.735	7,350	3.28	980
3—0	7.07	17.67	1.060	10,600	4.73	1,414
3—6	9.62	24.05	1.443	14,430	6.44	1,924
4—0	12.56	31.30	1.878	18,780	8.38	2,512
4—6	15.90	39.75	2.385	23,850	10.64	3,180
5—0	19.63	49.07	2.944	29,440	13.14	3,926
5—6	23.75	59.37	3.562	35,620	15.90	4,750
6—0	28.27	70.67	4.240	42,400	18.92	5,654
6—6	33.18	82.95	4.977	49,770	22.21	6,636
7—0	38.48	96.20	5,772	57,720	25.76	7,690
7—6	44.17	110.42	6.625	66,250	29.57	8,834
8—0	50.26	125.65	7.539	75,390	33.65	10,052

or to flux sand from the iron and particles of siliceous matter from the lining, so as to prevent accumulations which would interfere with the regular melting of the iron. Or the object may be to do this and also to purify the iron and to prevent absorption of injurious constituents. The usual loss of silicon and manganese cannot be classed as purification, as the reduction in amount is not always desired or necessary. Removal of sulphur may, in most cases, be called purification, but in other cases it may be necessary to retain or even increase the sulphur. Removal of oxides and prevention of increase of oxides are the only actions which are always desired.

Removal of Sulphur

Using coke containing about 1 per cent of sulphur and melting at a ratio of 10 to 1, there is sufficient sulphur present to increase the sulphur content of the iron by 0.10 per cent or to raise the sulphur content of the slag to 1.5 or 2 per cent. Ordinary cupola slag, however, seldom contains more than 0.10 or 0.20 per cent of sulphur. This is due to the slag being siliceous or acid in character. Large additions of lime would make the slag capable of taking up more sulphur, but the slag would rapidly attack the siliceous lining and would be too refractory for ordinary cupola operations. Increase of lime, to some extent, prevents increase of sulphur in the iron, and this must be due to the higher temperature necessary to melt the slag, being more favorable to removal of sulphur by oxidation. Manganese in the iron or manganese oxide in the slag, probably removes sulphur into the slag as manganese sulphide, and sulphur is then oxidized to sulphur dioxide which escapes in the form of gas.

Action of Slags

In the blast furnace the amount of oxide of iron in the slag practically depends on the temperature in the hearth of the furnace. The composition of the slag appears to have no influence. The metal, with exception of white iron or siliceous iron, usually shows no signs of oxidation.

In most of the steel-making processes the metal at some time during the process is in a highly oxidized condition, and steel free from the effects of oxidation is obtained, either by controlling the composition of the slag, by the addition of deoxidizing materials, or by both.

In the cupola, composition of the slag does not appear to have much effect, but it is reasonable to suppose that iron melted and held in contact with slags rich in oxide of iron will become oxidized to some extent. As the use of lime decreases the amount of oxide of iron in the slag, this must be more favorable to the production of metal free from oxides. In such a case the slag itself will, under suitable conditions, remove oxide to some extent from oxidized iron. The use of limestone is, therefore, advantageous in cupola melting.

There is no necessity for making any elaborate calculation of chemical compounds, as a cupola slag, like a blast furnace slag, cannot be made to accommodate itself to theoretical ideals.

Slags are usually controlled by following certain types of slag with a more or less flexible ratio of acid to base, or more generally, silica to lime or to lime and magnesia. In the cupola, slags seldom contain more than one part of lime to two parts of silica. This may, therefore, be adopted as a suitable basis for calculation. Using coke with about 10 per cent of ash, one-half of which is silica, and a melting ratio of 10 to 1, gives about 10 pounds of silica per 2,000 pounds of iron. Sand cast pig may carry 5 to 30 pounds of sand per 2,000 pounds of pig, according to time in stock and amount of handling it has received.

The Use of Scrap

Shop scrap, such as gates, runners, etc., may carry a great deal of sand, probably from 30 to 60 pounds or more per 2,000 pounds. Sand may be taken to be all silica for purposes of calculation. Silica from the silicon oxidized from 2,000 pounds of iron, is about 10 pounds. Silica from the furnace lining is variable and difficult to estimate, as it varies according to temperature and composition of the slag. A rough idea may be obtained from the amount of ganister used. As all figures are based on mere estimates, a rough calculation is all that is necessary. A few experiments using a pickling solution, or otherwise removing sand, would be useful for this purpose. Limestone will probably contain about 50 per cent or slightly above, of available lime. Therefore, equal weights of limestone to silica in the components of the charge used will give the proper amount to add, after making allowance for silica from the lining. Generally, the amount required will vary between 30 and 60 pounds per 2,000 pounds of iron.

Melting Borings

By N. W. Shed

Question:—We would like to obtain some information regarding the melting of cast iron borings in crucibles using oil as fuel. Our furnace has capacity for six or eight pots. What is the largest crucible which can be used economically for this work? How many heats could be obtained from a crucible under the most favorable conditions? How much oil would be consumed melting one ton of borings? what would be the quality of the iron if ordinary machinery borings were used? If the borings are heavily coated with rust, what will be the melting loss?

Answer:—A No. 60 crucible of 100 pounds capacity will be convenient for this work. As the borings melt, an additional 30 or 40 pounds can be added to the charge. The pot should have a life of at least 10 heats if the flame is without cutting action and if the crucible is handled carefully the number of heats should be increased to twelve. After the furnace has reached the melting temperature, you should be able to obtain 1,000 pounds of metal per hour and 50 gallons of oil should be sufficient for a ton of melted iron. The iron will be found to be considerably harder when remelted as there is a loss of silicon and carbon. High silicon pig iron or ferro-silicon can be added, which will soften the mixture. The oxidation due to rusty borings will probably show a melting loss of 6 per cent. An air furnace using fuel oil and equipped with an improved type of burner should show great melting economies.

Manganese as a Purifying Agent

The use of manganese as a purifying agent in aluminum bronze has been recently patented in France. The inventor prefers the use of the following composition: Copper, 86 to 95 per cent; manganese, 0.05 to 5 per cent, and aluminum, 6 to 11 per cent. The metals can be melted and alloyed in the usual manner, but it is imperative that a portion of the manganese be added at the time of casting, in the form of an alloy of copper or aluminum. A small proportion of manganese, it is claimed, acts as a purifier of aluminum bronze, removing impurities, other than oxides, which the aluminum fails to remove from the alloy. A large amount of manganese, up to 5 per cent, increases the hardness and malleability of the alloy.

THE BRASS FOUNDRY

Electric Furnace for Non-Ferrous Metals

AN ELECTRIC furnace for melting brass, drosses, scrap metals and other non-ferrous metals and alloys which is novel in design, as it is a combination of the arc and resistance types, has been developed by the Pittsburgh Electric Furnace Co., Pittsburgh. The furnace is the invention of R. S. Wile, general manager of this company. The original furnace was of the stationary type and was used for smelting tin drosses. A tilting furnace also is built which embodies the same principles of operation as the stationary melting medium. The tilting furnace, in melting and pouring position, is illustrated in Figs. 1 and 2, and Figs. 3 and 4 are sectional views.

Four carbon electrodes are used, two extending through the bottom of the furnace and the other two entering through the top. When preparing to make a heat, the furnace is partially filled with broken glass and the carbon electrodes are arranged so that they almost come in contact with each other. An arc is thus formed, which soon melts the glass surrounding it. The glass, in its molten state, becomes a conductor of the electric current, notwithstanding the fact that previous to melting it is a non-conductor. After the glass has been melted, the electrodes are drawn apart and the current passes through the entire glass bath, heating it to a high temperature, the glass becoming exceedingly fluid. The electrodes then are moved farther apart and the glass is maintained in a fluid condition. By this means all the resistance offered to the passage of the current by the glass serves to heat it and to maintain it in a molten state. Until the glass is in this fluid condition no metal is charged into the furnace.

When the glass bath has reached a high temperature the metal is charged and owing to the difference in specific gravities and the fluidity of the glass, the metal sinks to the bottom of the furnace. The glass serves, in addition, as a covering and completely protects the metal from oxidation, thereby reducing the loss to a minimum. The glass is the resistance material for heating the charge and also protects the metal. Any kind of scrap glass can be employed, broken bottles, window glass, etc., being equally effective. Nor is it necessary to make a new charge of glass every time a heat is tapped. Tests have proved that the glass can be used for several months of continuous work and when a new charge of glass is to be made, the molten glass is poured from the tilting furnace or is tapped out of the stationary furnace.

At Connellsville, Pa., two stationary furnaces have been installed for melting tin dross and slags. This type of furnace is recommended for large melts, but for small heats the tilting furnace has proved exceeding advantageous. The stationary furnace is built of fire brick, but it is essential to have a highly refractory lining to withstand the high temperature and corrosive action of the molten glass and metal. Chrome brick has given the best results. This brick is not only refractory and non-corrosive, but it also successfully withstands sudden changes of temperature. This is a feature of importance in the intermittent use of the furnace, as the repeated cooling and heating cause the brick to crack. The electric current used may be either direct or alternating, 110 or 220 volts. At 220

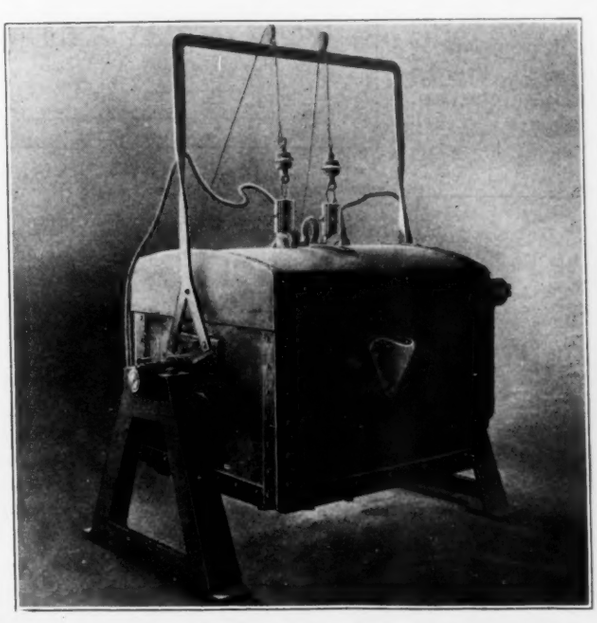


FIG. 1—ELECTRIC FURNACE IN MELTING POSITION

FIG. 2—ELECTRIC FURNACE IN POURING POSITION

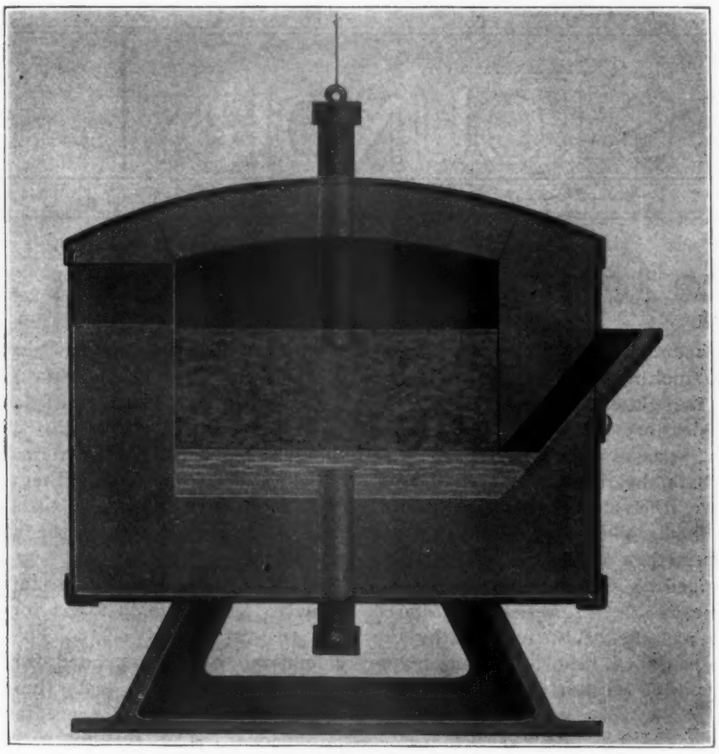


FIG. 3—SECTIONAL VIEW OF ELECTRIC FURNACE, SHOWING THE METAL AT THE BOTTOM COVERED BY THE MOLTEN GLASS

volts the charge of glass melts more rapidly at the beginning of a heat, but after the melting has begun the 110-volt current gives practically as good results. Carbon electrodes are used.

The tilting furnace is equipped with the same melting arrangement as the stationary furnace, with the exception that it is arranged to tilt to permit of easy pouring. For smelting drosses, scrap metals, etc., the stationary furnace gives excellent results, owing to the large quantities treated. The tap hole is plugged with an iron bar and when the melting operation is completed the bar is pulled out. The stationary furnaces are constructed in sizes up to 20 tons capacity, while the tilting types are made in various sizes up to 1,000 pounds a charge. If the voltage of the current is sufficient, two furnaces may be connected in series and a corresponding economy in current may be obtained. The temperature of the molten glass may be increased to 5,500 degrees Fahr. if necessary, without injuring the lining.

A furnace melting a charge of 220 pounds of brass will consume approximately 22 kilowatts of current at 100 volts. By connecting two furnaces in series a higher voltage may be employed or the current can be cut down by a rheostat; if necessary, a larger furnace can be used. From a 200-pound furnace a heat of this size can be poured in 30 minutes. A 500-pound furnace consumes 32 kilowatts and a 1,000-pound furnace will melt a ton of brass every hour and if run continuously will consume about 68 kilowatts in melting. Assuming that the furnace is not operated continuously and that electric current can be obtained for 2 cents per kilowatt, it has been found that the current cost for melting 1,000 pounds of brass will be $1.36. This is somewhat higher than melting with oil or coke, but the low melting losses more than compensate for the extra cost of fuel.

As the metals are constantly covered with the molten glass, the losses from oxidation are exceedingly low. In melting dirty brass scrap, such as sweepings and grindings, the loss has been kept as low as 1 1/3 per cent. This is based on the estimated amount of actual metal in the scrap. The loss on new metals has been as low as 0.33 per cent.

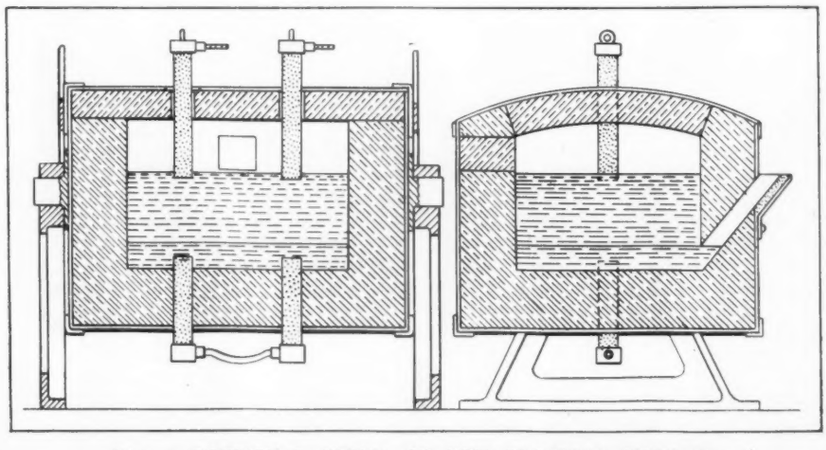


FIG. 4—SECTIONAL VIEWS OF THE ELECTRIC FURNACE

Canadium

A new metal of the platinum group has been discovered in the Nelson district of British Columbia by A. G. French, a Scotch metallurgist. The new metal has been named Canadium, and is found as grains in dyke rocks, varying from a few pennyweights up to three ounces per ton. The metal does not tarnish when exposed to dampness, and cannot be oxidized by the blowpipe. It has been definitely proved as being distinct from platinum, ruthenium, palladium and osmium, being much softer, and is easily melted by the flame of the blowpipe. Specimens of the new element have been sent for examination to the laboratories of Glasgow (Scotland) University. The mine in which it is found was discovered about six months ago.

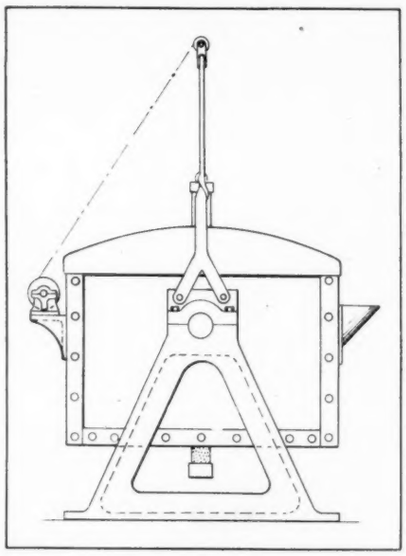


FIG. 5—END ELEVATION OF THE ELECTRIC FURNACE

British Brass Foundry Practice Discussed

Various Types of Furnaces Used for Melting Copper and Brass—Health Legislation for the Brass Molder

IN AN address on "Brass Foundry Practice," delivered before the Birmingham, Eng., branch of the British Foundrymen's Association, H. L. Reason, the newly elected president, stated that in view of the health legislation recently enacted in Great Britain, the first consideration when designing new shops is to insure ample ventilation. Unless the building is large enough to afford 2,600 cubic feet of air for each employe, artificial ventilation is necessary to remove the gases. One arrangement for the removal of fumes consists of a conical cover that is fitted to the crucible after it is withdrawn from the furnace. The apex of the cover is connected by a flexible tube with the furnace stack, and the fumes are drawn off the metal by the draft. The tube is composed of a coil of wire covered with asbestos cloth and is equipped with a damper which is closed when the cover is not in use. Several other methods of eliminating the fumes were described, one of which consists of hoods over the furnaces and skimming hearths. The hoods are equipped with fans which carry off the fumes by suction, and in this connection it had been found good practice to allow one square foot of opening for every six feet of skimming hearth, with not less than 1,000 cubic feet of air passing off per minute.

Furnaces

In describing the furnaces used for melting brass, the speaker stated that the reverberatory or air furnace is generally used when large quantities of metal are required, and that coal is the best fuel for such furnaces. It is essential when melting alloys to use great care to prevent the flame from becoming bright, clear and cutting, as such a flame indicates an excess of oxygen and causes the oxidation of the metal. This difficulty is obviated by the regulation of the current of air admitted through the doors attached to the ash pit of the furnace. The coal consumption of air furnaces from 2 to 20 tons capacity should be about 84 pounds to 112 pounds of metal. In the case of straight shaft, coke-fired furnaces the ash pit should be from 5 feet, 9 inches to 6 feet deep.

The furnace tops should be about 10 inches above the level of the floor when the crucibles in use contain up to 100 pounds of metal. This arrangement facilitates lifting-out the pots, as this operation is usually performed by hand when making small heats. When melting larger amounts than 100 pounds of metal per pot, the furnaces should be level with the floor, as some form of lifting device is usually employed in removing the pots.

Square and Round Furnaces

The square furnace, in the opinion of the speaker, is more economical than the round furnace, because the body of coke in the corners will do the melting, and at the same time allows room for the insertion of the tongs. A square furnace requires 1½ inches of coke at the sides for a crucible holding 100 pounds of metal, while in a round furnace of the same capacity, a 3-inch coke space is necessary. The round furnace is, therefore, 653 cubic inches larger than the square furnace, and will consume a larger amount of fuel. The coke consumption of natural draft, coke-fired, lift-out crucible furnaces is from 20 to 25 pounds of hard coke, for every 100 pounds of metal melted. The consumption of soft coke is from 25 to 50 per cent greater, but for small crucibles, 60 pounds or less, the difference is not so marked. The average temperature required in melting brass is about 2,480 degrees Fahr., but it was found that a number of furnaces were working at 2,250 degrees Fahr. When melting manganese-copper, and German silver, a temperature of 2,970 degrees Fahr. is required. The average melting loss is about 5 per cent.

Comparing good straight shaft furnaces with coke-fired, forced draft, tilting furnaces, the speaker claimed that the latter effect a saving in coke of from 10 to 15 per cent, and a saving in crucibles of about 25 per cent. Other advantages of this type of furnace are more rapid melting and lower labor cost. The blast pressure is very low, only 1½ to 2 inches water gage being required. The average life of crucibles in some tilting furnaces on which tests were made is 46 heats.

The oil-fired type of furnaces is very satisfactory for melting brass. In an open flame, rolling furnace, 600 pounds of metal can be melted in from 40 to 50 minutes, and 300 pounds of aluminum in 15 minutes. This type of oil furnace is not suitable for melting high zinc alloys, as the large amount of air blown in produces excessive oxidation. In another type of oil furnace, the melting and combustion chambers are separate, a feature that permits of greatly reduced oil consumption and blast pressure. The time required to melt 660 pounds of gun metal in one furnace of this type was one hour. The formula of the gun metal follows: Copper, 87 per cent; tin, 8.7 per cent, and zinc, 4.3 per cent. The oil consumption was 0.66 gallon for each 100 pounds of metal melted. Before charging the crucible, it should be raised to a white heat, and under no circumstances should the metal be placed in a cold crucible, as it will result in a loss of heat by radiation and will increase the melting point.

Alloys

In discussing copper alloys, Mr. Reason stated that the greatest tensile strength was attained with a 40 per cent zinc mixture. This alloy has a good red color, and it is possible to obtain 56,000 pounds tensile strength per square inch, with 50 per cent elongation. In the case of the copper, tin and zinc alloys, a series of tests were made to determine the effect of zinc on the tensile strength, and it was found that commencing with an alloy of copper, 85 per cent; tin, 10 per cent, and zinc, 5 per cent, the tensile strength was increased by decreasing the tin and increasing the zinc, until 10 per cent of the latter was reached, beyond which point the tensile strength was reduced. A chart by Thurston was exhibited which showed that the highest tensile strength was attained with about 83 per cent copper and 17 per cent tin, but the alloy was hard and brittle, with no elongation. The elonga-

tion is very important, and drops sharply just before 10 per cent of tin is reached, so that if the metal is not sufficiently hard with this amount, it is better to add phosphorus as a hardening agent, rather than to increase the tin, although in the case of bearings, 15 per cent of tin is frequently used. A good phosphor bronze for general work contains copper, 90 per cent; tin, 9.6 per cent, and phosphorus, 0.4 per cent. This alloy has a tensile strength of 40,000 to 45,000 pounds per square inch, with an alongation of 15 per cent in six inches. A harder metal follows: Copper, 88 per cent; tin, 11 per cent; phosphorus, 1 per cent. When a still harder metal is desired, 1.5 per cent of phosphorus may be added. The addition of phosphorus to copper and tin alloys up to 0.5 per cent has a beneficial affect, as it removes the oxygen and thereby increases the tensile strength and elongation; beyond 2 per cent phosphorus the metal is too hard and brittle to be of any use. The phosphorus can be added in the form of either phosphor-copper or phosphor-tin, just before the metal is taken from the furnace.

The addition of lead to any of these alloys reduces both tensile strength and elongation. Lead is usually added to improve the metal for machining, and for this purpose it should be kept within 3 per cent. In melting the metal, the use of fluxes is necessary if the melting is properly done. In the case of scrap metals, or where continued or bad melting has caused the metal to deteriorate, a small percentage of phosphorus varying from 0.05 to 0.25 per cent may be used, and will clear the metal of foreign matter and oxides. Other fluxes that are good deoxidizers are chloride of manganese and soda ash, which may be stirred into the metal in the proportion of one or two ounces for each 100 pounds of metal. When the alloy contains zinc the use of such agents is unnecessary.

Brass Foundry Difficulties

SOLVED BY EXPERTS

Phosphorus and Anti-Friction Metals

What effect has phosphorus on anti-friction metals having lead as a base? If added to a babbitt mixture having a tin base, will phosphorus promote fluidity to any extent, and as a deoxidizer is it any better than magnesium or aluminum in such alloys?

Phosphorus is frequently used in high lead anti-friction alloys, as it increases the fluidity and gives the metal a dense, fine grain. Theoretically it may be of no value as an addition to these alloys, but theory and practice do not always agree. For tin babbitts it is advisable to avoid its use, as it has a tendency to make the alloy viscid, which affects its fluidity. When a tin babbitt becomes thick because of dissolved oxides, sodium is the best deoxidizer that can be used. It must be used, however, in minute quantities, and to facilitate the addition, it first should be made into a rich alloy with tin, in the proportions of one ounce of sodium to each pound of tin. From one-fourth to a pound of the sodium-tin should be used in a bath of 500 pounds of babbitt. Sodium is no specific for thick tin and often it will appear to be of no use at all, in which case new metal may have to be added until the fluidity is restored. Magnesium should never be used in such alloys as it will cause drossing in the same manner as zinc. Magnesium can be added to alloys consisting of tin, zinc and copper, popularly known as white brass, but is inferior to aluminum, in preventing drossing and increasing fluidity. Aluminum is sometimes alloyed with tin babbitts, but it is doubtful if any advantage is derived from its use in improving the anti-friction qualities of the alloy and it also greatly reduces the value of the dross to the smelter.

Porous Castings

We are having trouble with poise bottoms and heavy brass beams for scales. The poise bottoms appear sound when cast, but when machined the side cast in the cope is found to be full of small holes, which extend into the casting to a depth of about 1/8 inch. The scale beams do not show this porosity, but instead are found to be full of minute cracks after the skin is removed. We melt with coal, the mixture being as follows: Copper, 17 pounds; tin, 1 pound; zinc, 1 pound, and lead, 1/4 pound.

The trouble in this case is undoubtedly due to the oxidation of the metal while in the furnace. No fault can be found with the mixture or with the use of coal as fuel. The most important point to be observed, when melting copper or its alloys, is to avoid undue oxidation, which is accomplished by keeping the surface of the metal covered. The best covering to use is charcoal, and it should be added, from time to time, during the progress of the heat, so as to keep a blanket of charcoal, about one inch deep, on the surface of the bath. If charcoal is not available, hardwood can be used and it is always a good plan to place a block in the bottom of the crucible, before the copper is charged. Glass is also a good covering for brass, and will not attack the crucible, but it is somewhat difficult to skim off. Salt frequently is used as a flux to prevent oxidation and is excellent in this respect, but if used in quantity, it produces very disagreeable fumes while the metal is being skimmed and poured. Covering the metal during melting will not always prevent the troubles outlined. The importance of constant attention cannot be overestimated, although this should not be construed as meaning that the furnace should be opened every few minutes. This would retard the heat unnecessarily. If the melter exercises good judgment he will understand that a short time after a new addition of metal has been made it should be pushed down into the molten mass gathering in the bottom of the crucible. There are very few cases of porosity that do not originate in melting, although wet sand and hard-rammed molds are often given as the cause of such troubles, although they seldom produce this result. The most prolific cause of spongy castings is due to the failure to push down the metal, which projects from

the crucible when melting has commenced. If the metal is allowed to sink of its own accord and unless its weight is sufficient to carry it through the charcoal cover on the bath, it will become oxidized and the oxide will be absorbed subsequently by the metal. This is frequently the case when light gates are added to new metal and if they are not given constant attention, they will carry a sufficient amount of oxide into the alloy to produce spongy castings. The cracks in the scale beams are another manifestation of the same trouble and will disappear if the metal is melted normally. While it is better to learn how to melt so as to avoid spongy castings and to obviate the use of deoxidizers, the latter afford a means by which such troubles can be overcome, and may prove advantageous in this instance. Therefore, if attention to the melting does not prevent recurrence of the difficulty, try an addition of ¼ pound of 15 per cent phosphor-copper in your mixture.

Blast Furnace Tuyeres

We have an order for blast furnace tuyeres which must be made of copper and we would like to know whether silicon-copper would be suitable for this purpose? The mixture must consist of two-thirds scrap and one-third new copper. Would it be safe to use the silicon-copper in the old material and if so when is the proper time to add the silicon to the copper? What effect would a larger quantity of silicon-copper than 2½ per cent have upon the metal; also what effect would it have upon common yellow brass if added to the copper in making this alloy? In a mixture of copper, 85 per cent; tin, 11 per cent, and lead, 4 per cent, would the addition of silicon improve the metal and increase its hardness and would it not be possible to make our own silicon-copper by melting together 12½ per cent of silicon and 87½ per cent copper?

Silicon added in the form of silicon-copper is the best deoxidizer of copper that has so far been discovered and you need anticipate no trouble from its use, whether the copper charge is composed of all new metals or all scrap or any proportion of either. The silicon-copper should be added to the copper when the latter is sufficiently hot to pour and the metal should be removed from the furnace 10 minutes after the silicon has been added. Use charcoal or hardwood as a cover on the copper, melt quickly, and do not keep it in the furnace any longer than is necessary. There is nothing gained by using more than 2 per cent of silicon-copper and if the copper is well melted, 1 per cent will be sufficient to make solid castings. For tuyeres, silicon is especially valuable as it makes the copper so fluid that it runs without difficulty. Use the 10 per cent silicon-copper and if the metal is too soft, harden with tin. Silicon hardens copper, but a considerable quantity must be used; thus there is no appreciable hardening effect when 10 per cent of silicon-copper is added to copper; up to this point its influence seems to be rather to soften the metal. The effect of silicon on yellow brass is similar to that of aluminum, that is, it adds fluidity and gives the metal the same appearance. However, while aluminum can be used in a leaded alloy, silicon cannot, as it causes excessive drossing. The effect of silicon on the bronze mixture given would be to produce so much dross that the metal could not be used for sand castings, unless the percentage of silicon is extremely low and even then it produces brown discolorations which are visible in the fracture of the metal. Silicon is at its best in copper and as stated, is the best deoxidizer known. Although the conductivity of the metal is not as high as when magnesium is used, the silicon will produce a more reliable casting. It can be used in yellow metals also when lead is absent, but for copper and tin alloys, phosphorus is better than silicon. It is not advisable to try to make your own silicon-copper, as it cannot be accomplished in the brass foundry without getting iron into the metal. It is advisable to purchase the silicon-copper from some reliable maker.

A new anti-friction metal, recently patented by W. Myers, of Norristown, Pa., is made as follows: Zinc, 78 per cent; copper, 12 per cent; lead, 7 per cent; iron, 2 per cent, and manganese, 1 per cent. The inventor recommends this metal for bearings, bushings and other castings where an anti-friction metal is desired.

The Osborn Mfg. Co., Cleveland, manufacturer of molding machines and foundry supplies, announces the purchase of the business and plant of the Colonial Brush & Mfg. Co., 348 Florida street, Milwaukee. This plant will be known hereafter as the Osborn Colonial Works and will be under the direction of E. F. Streich, resident manager.

Red Brass Scrap

What mixture of red brass do you suggest as being suitable for use in making common bushings? The metal must be clean and rather soft, and we would like to use some scrap in the mixture.

An excellent alloy for this work follows: Copper, 84 pounds; tin, 4 pounds; zinc, 6 pounds, and lead, 6 pounds. The amount of scrap that can be used with this mixture will depend entirely upon the quality of this material. If it is in the form of old car brasses, it would not be advisable to use it in the new mixture, but if a good grade of red brass scrap can be obtained, good castings can be made without any admixture of new metals.

Whether scrap shall, or shall not be used in making brass castings, depends entirely upon the foundryman's ability to sort it. A knowledge of scrap is only gained by experience in handling metals coupled with the intelligence necessary to observe and to note the peculiarities that distinguish the different properties, as exhibited by the fracture and general appearance of the metal. Another aid in sorting scrap is a knowledge of the uses of the metal object, as this furnishes a fairly reliable index of its nature. Thus, for instance, large engine bearings, keyheads, rod brasses, driving brasses and gibs are usually made of *hard brass*. This metal is high in tin and comparatively low in zinc and lead. Consequently, by a judicious proportioning of such scrap when available, tin can be dispensed with almost entirely. Such scrap as trolley wheels and splicers, and other electric railway overhead scrap that has been bent to grip the trolley wire, consists of soft metal and can be used safely to the extent of 50 per cent in the mixture given. Valves and steam fittings are not always to be depended upon, as they often contain enough iron to produce discolored castings. Therefore, such material should be used with caution until its freedom from impurities has been determined by trial. Scrap metals is a theme too extensive to be more than touched upon here, but it may be stated that if clean, red brass scrap can be obtained, it may be used up to 50 per cent of the contents of the crucible. Occasionally, however, it must be expected that a heat will fall below standard, because a piece of scrap that contains aluminum or iron will sometimes find its way into the metal.

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Trade Outlook

HOW'S business? Ask the steel manufacturer. His plants are operating at from 75 to 80 per cent of their capacity. What is more, the indications are that they will continue to operate at this rate throughout the first half of the year. And an active steel trade foreshadows improvement in the foundry industry. Already some of the jobbing shops report better inquiry and the melt is slowly, but steadily increasing. For months the foundry trade has been characterized as *spotty*. Some shops were running overtime, while others were taking off only a few heats each week. The specialty foundries, with few exceptions, have been enjoying a normal demand, although some of the malleable and steel shops, dependent largely upon railroad business, have been running light. The improvement in the supply trade reflects a greater foundry melt and generally improved trade conditions foreshadow increased activities for the casting shops. Gray iron shops specializing in automobile work are running double-shift and the brass shops and aluminum foundries are equally well engaged. Presidential years are not necessarily off years, in fact trade statistics prove the reverse to be true. The political turmoil has been discounted almost entirely and the average manufacturer is too busy to listen to the agitation of the radicals. Prices for castings are still low and in many instances barely represent the cost of manufacture. Raw materials, likewise, are quoted at low levels and notwithstanding the increased iron consumption, pig iron prices have not advanced. In the leading centers, No. 2 foundry iron is held as follows: Pittsburgh, $13.90 to $14.15; northern, Chicago, $14; New York, $14.70; southern, Birmingham, $10. Other grades: Malleable Bessemer, Pittsburgh, $13.65 to $13.90; Lake Superior charcoal, Chicago, $16.50, and basic, Pittsburgh, $13.40.

A Test Bar Joke

ONCE upon a time—and not many moons ago—a brilliant young engineer designed a high power pump for a new municipal water plant. The station was large and six pumps were installed. The specifications measured up to the usual impossible standards and those applying to the castings were drawn as specifications never were drawn before. This brilliant designer was not satisfied with a set of test bars from every heat—by no means. He demanded a set of bars from every charge that went into the cupola. He failed to explain how they were to be obtained and the foundry superintendent in charge of the casting work likewise failed to ask for an explanation. The super's gray matter, however, was at work. He concluded that there would be *enough* test bars and even if the specifications required test bars only, he was prepared to furnish them. Test bars from every charge—never. There was

an easier way. Why not cast them in quantity for a month's operations? Also reduce the molding cost. This was an after-thought. The test bar patterns were mounted on a molding machine and in a few hours a sufficient number of molds were made for a month's supply of bars. Of course the bars were properly dated to record each heat. All of the bars were cast at one time, but were carefully assorted and bundled to avoid the possibility of casting next week's heat yesterday. The inspector made his rounds at regular intervals once each week and after testing two or three bars from each day's melt passed the material as satisfactory. Necessity is the mother of invention. The foundry superintendent was of an inventive turn of mind and succeeded in taking the engineer over the hurdles at a pace he had never before experienced. Moral.—There are specifications and *specifications.*

Publicity for Molding Time Data

IN THE FOUNDRY, January, 1912, an article was published which described a method of computing molding time by the use of a slide rule, following the principles laid down by Frederick W. Taylor. To practically apply this rule, it is necessary for each foundry to make an elaborate series of time studies to determine the proper values for the intricacy factor. Shops which have made a practice of keeping accurate records of their molding time will be able to compute their intricacy factors from these records without loss of time, but plants which have such data are comparatively few. It is generally true, therefore, that before the system of computing molding time, as outlined in this article, can be available for use, a tremendous amount of work must be done by a large number of shops in obtaining records of the actual time required to mold the various standard patterns. It is evident at first glance that this would involve a great deal of duplicate effort, since each shop is obliged to determine its own factors without much knowledge of what its neighbors are doing. This state of affairs is due to a feeling of unfriendliness between some manufacturers, but fortunately this unwillingness to co-operate is less pronounced at the present time than it was a decade ago. This is due to the educational influences of the various foundry associations and technical journals, but is still sufficiently powerful to prevent a great deal of effective and beneficial co-operation. Without any reference to the particular method of computing molding time as outlined in this article, it is true that any rational method of obtaining foundry costs involves an accurate knowledge of molding time. Records of the time required to mold certain standard patterns particularly are among the most valuable data which any foundryman can possess. While every shop has this information, compiled from its own experience, in a more or less complete fashion, there is a scarcity of comparative records on this subject. There is no standard by which any given performance can be compared and very few shops, therefore, have any accurate method of measuring their efficiency, as far as molding operations are concerned. If a large number of foundries in this country could be persuaded to collect some accurate information regarding the molding time on standard patterns, such as pulleys, engine cylinders, drums, sheaves, shaft hangers, pillow blocks, etc., and then could be induced to submit this information to some responsible central authority, where it could be properly collected and published for the use of everyone in the trade, the benefit which would be conferred upon the science of foundry practice as a whole and upon each individual shop concerned would be immeasurable. Such data would form a standard with which individual results could be compared and by which efficiency could be judged. At the present time there is no reason why the molding time for a 10-inch, 5-arm pulley in a Chicago foundry should be any different from that required for the same job in a Baltimore foundry. And there is no reason why the records achieved in each shop should not be known to both, to their mutual advantage. If such records and standards could be compiled and recorded it would save an immense amount of useless labor, since under the present system each generation of foundrymen is obliged to compile this data through individual effort. More light on this subject of molding time from every possible source cannot possibly do anyone any harm and is certain to do the industry, as a whole, a wonderful amount of good.

Semi-Steel---A Misnomer?

SEMI-STEEL, whether a mixture, a metal or merely a condition, is receiving constantly increasing attention from foundrymen manufacturing close-grained castings. The largest engine builders in the world are using semi-steel in their cylinders and the practice of adding steel in the cupola is growing at a rapid rate. Semi-steel may not be recognized in iron and steel nomenclature, yet it ranks among the most valuable products of the gray iron foundry and should, therefore, be accorded proper recognition. It has been claimed that the charging of steel in the cupola, at best, would give only an uncertain mixture. But results count. The product can be and is closely controlled. In a large pump manufacturing plant in the east semi-steel is employed to the exclusion of other mixtures. As high as 33 per cent of steel is charged and for heats, 6,000 pounds and less, is dumped into the cupola on top of the first pig iron charge. When the heats exceed three tons the steel is divided into two charges. Ferro-manganese is added to the steel charge in the cupola in the proportion of two pounds of manganese to 100 pounds of steel. A small amount of aluminum is added in the ladle and the metal is poured immediately after the agitation of the mass has ceased. In Germany the converter is employed for semi-steel manufacture. Part of the metal is blown for a short period and is added to the molten iron in the ladle. It is claimed that a product is obtained superior to that made in the cupola.

Equipment for the Foundry and Pattern Shop

A Novel Core Testing Machine—Machine-Molded Street Railway Brackets—A 120,000-Pound Jarring Machine—Turbine-Driven Blower Unit—Jolt-Ramming Machine Valve—Furnace for Annealing Steel Castings—Pistol Sprayer

FOR the purpose of comparing the strength of various core binders and core mixtures, a core testing machine, shown in the accompanying illustration, is now manufactured. In the development of a machine for this purpose, a series of experiments on core mixtures were undertaken about five years ago by Geo. H. Wadsworth, of the Wadsworth Core Machine & Equipment Co., Akron, O. A number of different methods of testing cores were tried, but the choice lay between tension and transverse tests. The transverse test on a one inch square core, 15 inches long, gave fair results on very strong cores made from oil sand mixtures used for radiators, gas stove burners, etc., but it was found difficult to turn out these large cores in quantities without rods and at the same time to be certain that they would not contain mechanical defects which influenced the strength. It was also found that the transverse test on bars of this length was not sufficiently delicate for a comparison between mixtures of approximately the same strength.

For making the tension tests a cement testing machine was first employed and this was found to be excellent for very strong cores, but was not sufficiently delicate for the weaker mixtures used in gray iron, brass and malleable foundries. Another machine was tried, but as its capacity was limited to 50 pounds per square inch, it was not entirely satisfactory and it was concluded to develop a core testing machine on entirely different principles. The core to be tested is made in the form of a concrete briquette, having an area of one square inch in the center. The core is placed between the jaws in their closed position, as shown at *B*, Fig. 1. In this view, however, the core is not shown. The galvanized pail, *D*, is suspended from the lower jaw in such a way that it is supported by the core. The hopper, *E*, is filled with shot and by raising the pin, *A*, to the top of the slot in the lower jaw, a small gate at the bottom of the shot hopper is opened and the shot is permitted to flow into the pail. When the weight of the shot in the pail causes the test core to break the pins separate, as shown at *C*, Fig. 2.

When the lower jaw descends it carries with it the pin, *A*, Fig. 1, thereby automatically closing the shot valve in the hopper, *E*. This jaw, however, is so arranged that the pail and jaw remain supported on the pin, *A*, without coming in contact with the base of the machine. The pail is then removed from the hook and is hung on the spring balance, as shown in Fig. 3. To obtain the full weight required to break the core, the weight of the lower jaw must be added to the weight of the pail and shot. This gives a direct reading of the weight necessary to break the core. This operation is very simple and two cores per minute can be tested readily.

When it is desired to carry out a series of tests with a new lot of sand, oil or binder, two batches of cores are made with the same sand, one being mixed with old binder and the other with the new, both in the same ratio. These cores are baked on the same plate in the core oven in alternate rows and after cooling are broken. The baking temperature will have a considerable effect on the strength of the cores, but both samples will be similarly affected so that with this method of procedure an exact comparison of the strength of the two binders can be made.

It has been found that the variations in the clay content of the sand, the amount of dirt it contains and the size of the sand grains may have a marked effect on the strength of the cores and, therefore, any new lot of sand should be tested. Samples of the new and old sand should be used for the core mixtures, using

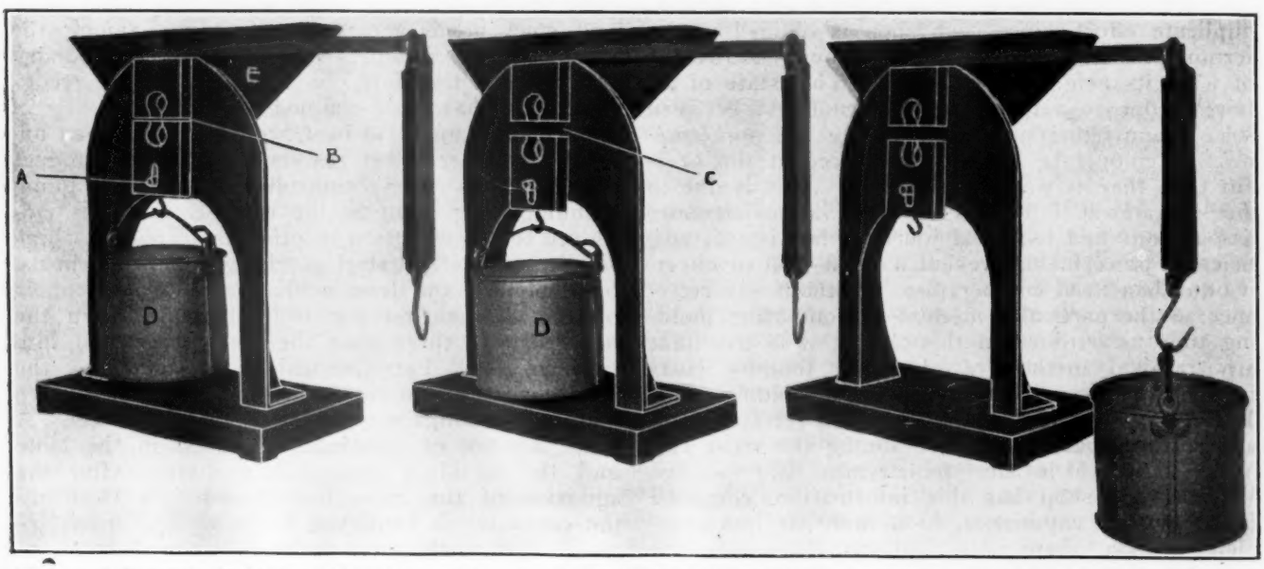


FIG. 1—JAWS IN CLOSED POSITION BEFORE BREAKING TEST CORE

FIG. 2—JAWS SEPARATED AFTER TEST CORE HAS BEEN BROKEN

FIG. 3—WEIGHING PAIL TO ASCERTAIN STRENGTH OF CORE

the same binder for both. The cores should be baked on the same plate in the manner as previously described and the strength of the new sand can be obtained readily by the tests of the cores. It is advisable to make test cores from the regular mixtures each day, which are baked with the cores used in the foundry and if the temperature of the ovens is too high or too low, these test cores will not develop the proper strength. In this way the core mixtures and the core oven temperatures can be checked day by day. The strength of the cores can be easily controlled within very narrow limits. By the installation of one of these testing machines the core room practice can be checked daily and at a very low cost. This machine is built by the Wadsworth Core Machine & Equipment Co., Akron, O.

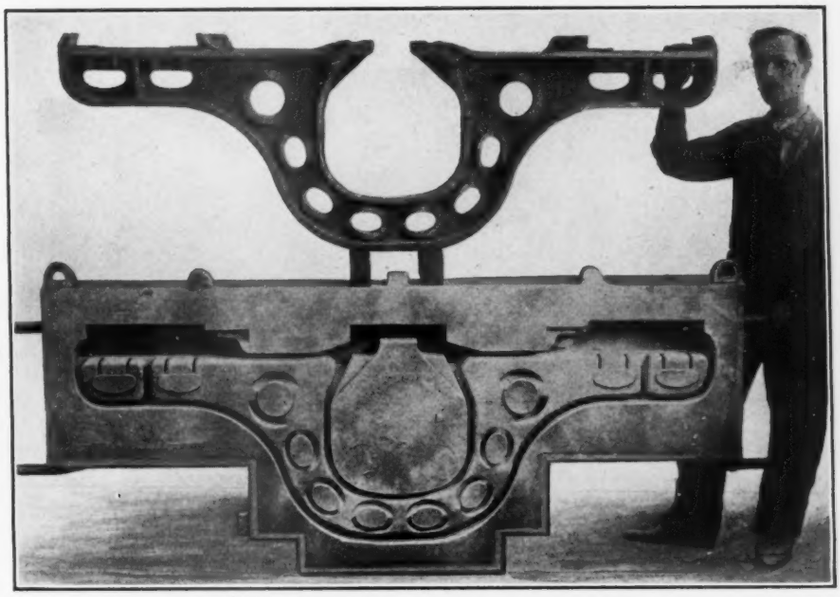


FIG. 2—ONE-HALF OF MOLD FOR STREET RAILWAY BRACKET AND THE WOOD MASTER PATTERN

Machine-Molded Street Railway Brackets

In the underground electrification of the street railway system of Paris, France, a large tonnage of rail brackets is being used. These brackets form not only a slot for the underground wires, but likewise serve as supports for the rails. The pattern of one of these brackets is shown on top of the mold, Fig. 2. In the foundries in which these brackets are being cast all of the molds are made by machines and practically all of the shops are using large molding machines built by Ph. Bonvillain & E. Ronceray, Paris, as shown in Fig. 1. In this view the head is shown swung aside with one-half the pattern on the machine table. Flasks cut out to closely follow the contour of the pattern are used in practically all of the foundries and in those shops where flasks are used without bars or with only a few bars, the drawing of the pattern is facilitated by the use of stripping plates. By the use of barred flasks, however, the stripping plate has been entirely eliminated in some shops. By the aid of a crane for handling the flasks and molds, six men average from 35 to 40 molds per day, including the casting and shaking-out. Each casting weighs 375 pounds.

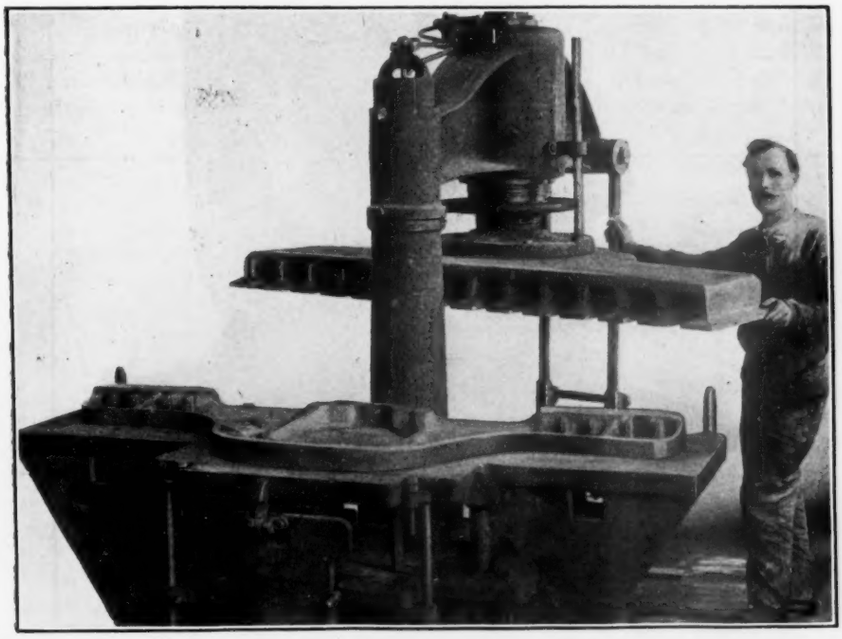


FIG. 1—FRENCH MACHINE FOR MOLDING STREET RAILWAY BRACKETS

New England Foundrymen's Association

At the sixteenth annual meeting of the New England Foundrymen's Association, held at the Exchange Club, Boston, Jan. 10, a report from a committee appointed at the previous meeting to consider lower freight rates on pig iron from the Birmingham district was submitted. It was accepted as progressive and the committee was continued with instruction to further co-operate with the associations interested in the movement to bring about a reduction in the freight tariffs in question.

Officers for the ensuing year were elected as follows: President, Chas. L. Newcomb, Deane Steam Pump Co., Holyoke; vice president, Robt. C. Bird, Broadway Iron Foundry, Cambridge; treasurer, Geo. H. Lincoln, G. H. Lincoln & Co., South Boston; secretary, Fred F. Stockwell, Barbour-Stockwell Co., Cambridge, Mass. Executive committee: Chas. L. Nutter, Old Colony Foundry Co., East Bridgewater; Chas. A. Reed, Hickman, Williams & Co., Boston; J. C. Hosford, Magee Furnace Co., Chelsea; D. K. Bartlett, Builders' Iron Foundry, Providence, and A. L. Clark, American Brake Shoe & Foundry Co., Norwood, Mass.

The report of the secretary showed a membership of 130 firms. The banquet in the evening was attended by 125 members and guests. Chas. L. Newcomb, of Holyoke, was toastmaster, and the principal speakers were Rev. John S. Lyon and Dr. P. T. O'Reilly.

JAR-RAMMING MACHINE OF 120,000 POUNDS LIFTING CAPACITY, BUILT BY THE HERMAN PNEUMATIC MACHINE CO. FOR THE MESTA MACHINE CO.

A 120,000-Pound Jarring Machine

In the accompanying illustration is shown a large jar-ramming molding machine, built by the Herman Pneumatic Machine Co., Zelienople, Pa., which was recently installed in the gray iron foundry of the Mesta Machine Co., Pittsburgh. The table plate is 8 x 12 feet and the base is of corresponding dimensions. The cylinder is 40 inches in diameter and has a lifting capacity of 120,000 pounds. The base is made of cast iron and the table is cast steel. An automatic self-control valve of the latest Herman type is employed. It consists of a top and bottom head, double check valve stem and differential piston and body. All operating parts are inside of the body and the only openings consist of the inlet, the opening into the cylinder and the exhaust to the atmosphere. The seats of the valve are so arranged that they may be reground easily.

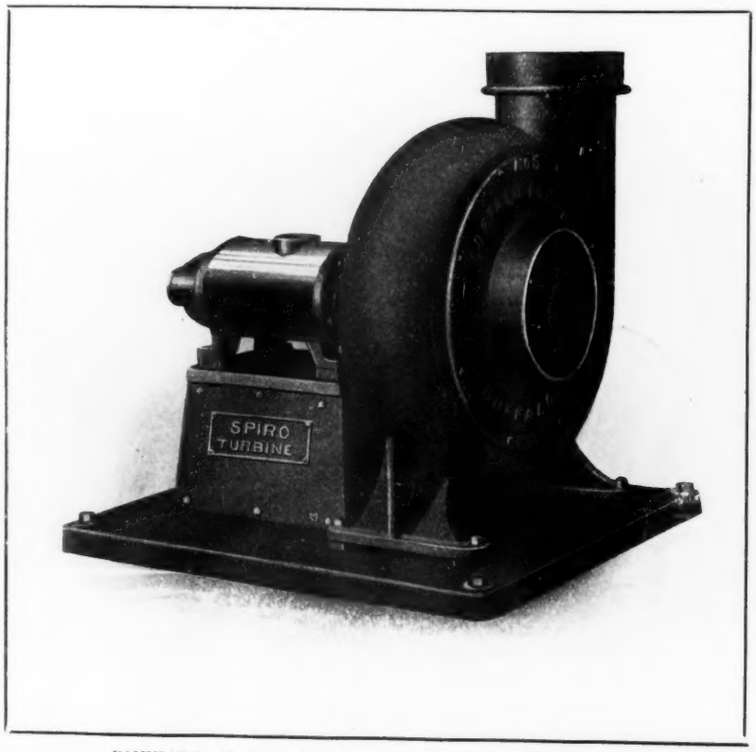
The valve is constructed to consume only a sufficient amount of air required to lift the load and produce the proper number of blows per minute necessary for ramming the mold. The valve is placed directly against the port of the cylinder, thereby insuring the greatest efficiency.

The table plate is provided with eight long guides lubricated through four pockets which are packed with waste and oil. The guides are provided with wearing plates of the same dimensions, which are adjustable and are concealed in the base. The table is a one-piece steel casting properly ribbed to reduce the weight without affecting the strength of the table. The plunger is a one-piece cast steel section which is bolted to the table plate and is provided with expanding packing rings. The table plate falls on 30 resilient jarring surfaces, equally distributed around the top of the base. The aggregate area of these surfaces is 590 square inches. Both cope and drag halves of molds have been successfully rammed on this machine and the molds have been poured at distances of less than 20 feet from the machine while it was in operation. This indicates that, notwithstanding the size and power of the machine, practically no vibration is imparted to the surrounding floor, the shock being absorbed by the resilient surfaces in the base. A duplicate of this machine will be built in the near future for use in the steel foundry operated by the Mesta Machine Co.

Turbine-Driven Blower Unit

A turbine-driven blower unit, built by the Buffalo Forge Co., Buffalo, is shown in the accompanying illustration. The turbine is of the combined impulse and reaction type and consists essentially of five parts, including the case, two heads with bearings, and two rotors. The rotors consist of helical gears and contain neither loose nor inserted blades. The pocket is so designed that the steam action makes full use of the impact of the fluid due to its velocity and leakage is avoided entirely. The turbine is exceeding small in size, but is manufactured in capacities from 1 to 50 horsepower, non-condensing, and patterns also are being made by the Buffalo Forge Co. for additional sizes up to 300 horsepower.

There are only two points of wear in this turbine, the bearings and the tooth contacts. The lubricating system for the bearings is so designed that each bearing acts as an individual oil pump, circulating oil through the bearings between the shaft and bushings at a positive pressure. A perfect oil film is thus formed and as long as there is oil in the reservoirs or oil chambers which form part of each



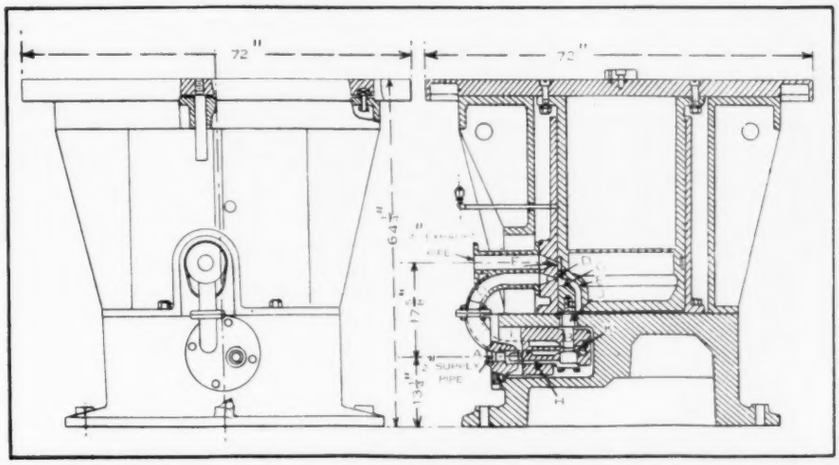
BUFFALO FORGE TURBINE-DRIVEN BLOWER UNIT

bearing, this oil film is maintained automatically. The length of the spiral rotors is much greater than would be necessary for the face of spiral gears transmitting equal loads at equal speeds and as a result the maximum tooth pressure per square inch is limited to five pounds. It has also been found that a film or cushion of steam is at all times maintained between the teeth of the rotors, which causes an elastic contact sufficient to produce great smoothness of action.

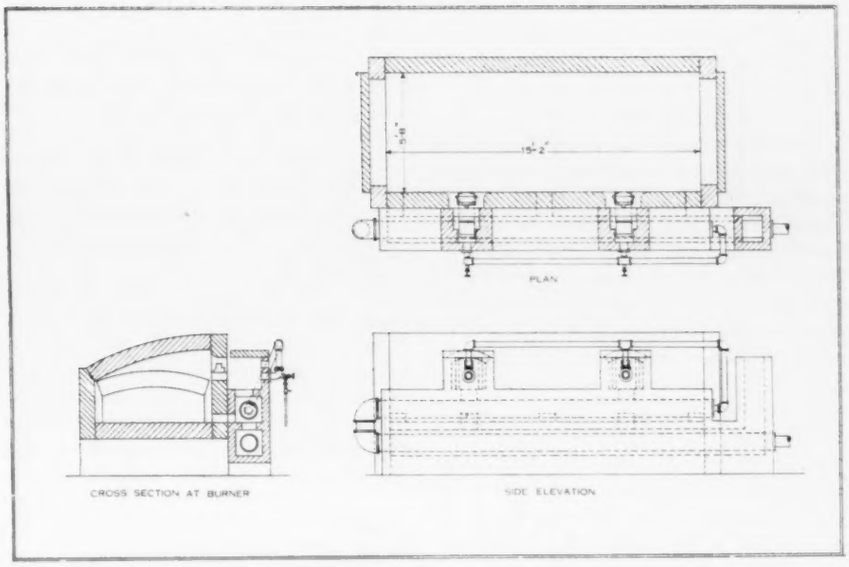
New Valve for Jolt-Ramming Machine

The new valve for jolt-ramming machines, designed and built by the Mumford Molding Machine Co., Plainfield, N. J., is of unique construction in that it is actuated by the air independently of the velocity of the rising table, without imposing any burden upon the entering air column. The valve contains no springs and is exceedingly simple in design. In the accompanying illustration this valve is shown applied to a 24-inch jolt-ramming machine, equipped with a table, 72 inches square, and has a capacity to ram molds weighing 12 tons.

As shown in the cross-section of the machine the air enters at *A* and passes around the stem of the valve, *B*, to the bent tube, *C*. From this tube the air enters the space in the side of the main plunger at *D*. Through the port, *E*, the air reaches the cylinder and raises the main plunger with its mold table. When the lower edge of the packing ring on the main plunger uncovers the exhaust port *F*, the rising shoulder, *G*, of the main plunger obstructs the entering air. With the exhaust open and the entering air blocked off, the pressure falls rapidly under the main plunger and while the table is falling to impact, valve, *B*, blows up into the reduced pressure in the cylinder and positively cuts off the entrance of air. The pressure which forces up valve, *B*, is line pressure introduced through the by-pass, *H*, and this pressure holds up *B*, with the air cut off, until, just before impact, the projecting part, *J*, of the main plunger forces valve, *B*, open and readmits air for the next blow. The valve, *B*, is carried in a readily removable plug, *I*.



SIDE ELEVATION AND CROSS-SECTION OF MUMFORD JAR-RAMMING MOLDING MACHINE, SHOWING VALVE MECHANISM



PLAN, SIDE ELEVATION AND CROSS-SECTION OF FURNACE FOR ANNEALING MANGANESE STEEL CASTINGS

A Furnace for Annealing Steel Castings

An oil-burning annealing furnace embodying a number of interesting features of design has been installed recently at the Indiana Harbor, Ind., works of the American Steel Foundries. The furnace is used for annealing manganese steel castings and was designed by F. S. Richmond, consulting engineer, Fisher building, Chicago, under the F. J. Nice patents. Its principal features are shown in the accompanying illustration. The new furnace was rebuilt from an old one of the same dimensions, 5 feet, 8 inches wide and 15 feet, 2 inches long inside, with an effective area of 45.3 square feet, for castings, but as rebuilt now has an area of 86 square feet. This increase in capacity has been accomplished by removing the old bridge wall and making the entire hearth of the furnace effective.

As now designed, the furnace is charged with about six tons of castings, varying in weight from one to 200 pounds, all of which are raised to a temperature of 1,825 degrees Fahr., soaked for two hours and then quenched in water. The castings are piled on racks and are charged through the end doors, the two burners being placed in one of the side walls.

In operation there is no flame in the furnace chamber to strike the castings or to produce hot spots on the walls, the flame being diverted by the wedge-shaped blocks placed directly in front of the burners. No excess air is admitted above that required for complete combustion at the temperature desired. There is, therefore, no smoke in the furnace and the surplus gases pass out through the vent shown on the drawing, but before being allowed to escape they are used to preheat the air delivered to the burners. The oil is delivered to the burners at a pressure of 15 pounds per square inch and at a tem-

perature of 100 degrees Fahr. The air is delivered at a pressure of 20 ounces and at a temperature of 400 degrees.

Oil Burning System

The atomized oil, being ignited in the combustion chambers, strikes the combustion blocks which break up the flames, and complete combustion takes place before the gases enter the furnace. The hot gases are spread out fan-shaped when leaving the combustion blocks, insuring a wide distribution in the furnace. The pressure from the burner forces the gases along the arch to the side walls and ends, and thence down to and across the hearth to the take-up flues shown in the walls below the burners. This flow is aided by the injector action of the burners, which draw the gases from the air heating chambers through the up-takes, which connect these chambers with the combustion chambers. Therefore, a regenerative effect is obtained by causing part of the heated and spent gases to circulate through the furnace a second time. The excess gases which are not used in this manner enter the air heating chambers, pass around the air drums therein and then escape through the vent.

In a test of this furnace, temperature readings were taken at various points over the hearth by a Bristol indicating pyrometer and also by a Brown radiation pyrometer, at points on the side and end walls. These readings all coincided within the limit of error of the instruments, which was 10 degrees. The blast was furnished by a Connersville blower, delivering 550 cubic feet of air per minute at 1½ pounds pressure. A rotary pump is used for circulating the oil and it is provided with a relief valve which acts when the burners are shut-off. The oil is strained and heated by a steam coil. During the test the furnace was operated on cold air with the thermometer at zero degrees Fahr.

A Core and Mold Sprayer

In the accompanying illustration is shown a compressed air device for spraying blacking on molds and cores, designed by James A. Murphy, foundry superintendent of the Hooven, Owens & Rentschler Co., Hamilton, O. The sprayer is provided with a trigger control and can be operated with one hand. Molds can be blackened in one-fourth the time required to swab or brush them. The sprayer can be inserted into pockets, deep flanges and parts of molds inaccessible to the brush or swab. Copes or other parts of molds can be blackened overhead without the attendant waste of applying blacking by hand. As the blacking is discharged from the sprayer under pressure it is forced into the pores of the facing sand where it is retained and increases the depth of fireproof coating on the mold or core. Blacking applied in this way, it is claimed, will not flake off. The valve is of bronze construction resting on a cast iron seat and the intake and suction holes are slightly larger than are required. A reducer is inserted in each opening so that the wear from coupling and uncoupling of the hose is limited to the reducer, and when the threads are worn out a new one

A PISTOL SPRAYER FOR BLACKING MOLDS AND CORES

can be inserted at a small cost. When the trigger is pulled the air passes through the valve, increasing in velocity as it passes through the small orifice, after which it expands. Its expansion in the barrel creates a suction in the chamber to which the suction hose is attached. The nozzle is made of ½-inch pipe or smaller, depending upon the size of the spray.

John N. Allen, 738 Oliver building, Pittsburgh, has been appointed sales agent in the Pittsburgh district for the Monarch Engineering & Mfg. Co., Baltimore. This company builds crucible melting furnaces, core ovens, oil burners, blowers and heating furnaces for rivets, bolts, bars, angles, plates, etc.

Dull Iron

By N. W. Shed

Question:—We specialize in gray iron toys, novelties, etc., which require hot, fluid iron. We are experiencing considerable difficulty, however, during the last half of the heat, as the iron becomes dull and when we drop bottom we find that the cupola charge has bridged immediately above the tuyeres. This seems to be caused by the chilling of the iron by the blast. The cupola is 56 inches in diameter and is lined to 38 inches inside. It is equipped with six straight tuyeres, 4 x 8½ inches, flaring to 4 x 15 inches. These tuyeres are located 14 inches above the bottom doors. The blast pressure at the beginning of a heat is 9 ounces and is increased to 11 ounces. The schedule of our charges follows: The coke bed, amounting to 390 pounds, is lighted with an oil burner at 2:15 p. m. and later we charge 400 pounds of coal and 130 pounds of coke. The total bed charge of fuel is 820 pounds. The bed reaches a height of 26 inches above the tuyeres and at 3 o'clock we make the first iron charge. This consists of 1,000 pounds of broken pig and 900 pounds of clean scrap. Subsequent charges consist of 130 pounds of coke and 1,095 pounds of metal. At 4 o'clock the blast is turned into the cupola. We have varied this method of charging, but the most satisfactory results have been obtained from the method outlined.

Answer: — Your difficulties are due either to the coke or the blast, as the iron should be hotter after the middle of the heat than during the first part of the heat. The first charge of coke and iron is too heavy. You will find that 700 pounds of coke and 1,200 pounds of iron will give you better results than your present method of procedure. All of the coke constituting the bed should be well-lighted and settled before the blast is put on. The subsequent charges should consist of 150 pounds of coke and 1,200 pounds of iron. The bridging of the charge is due largely to a hard cinder, which should be kept melted. This can be accomplished by adding 100 pounds of limestone to the coke on the bed and 30 pounds of limestone to each coke charge thereafter. If your heats are large it might be advisable to tap the slag from time to time. The tuyeres in this cupola are too high for small amounts of hot iron. They should be located not more than 8 or 10 inches above the bottom so as to permit the molten iron to run into the ladles immediately to avoid cooling in the

bottom of the cupola. If the cupola runs very hot iron on this burden, the amount of coke can be reduced from 150 to 120 pounds for the last charges.

By W. J. Keep

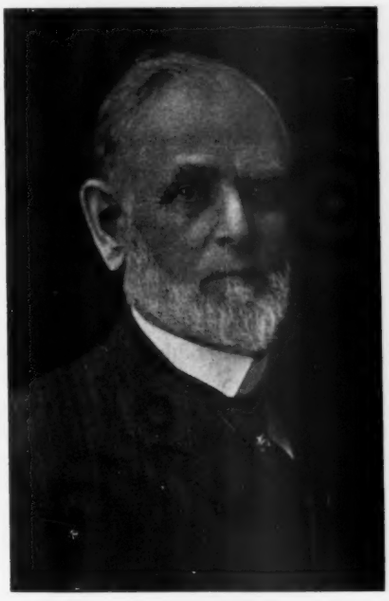
Answer:—Your cupola and blast are satisfactory, but you have omitted stating the number of charges you make during a heat. I assume that you melt six or more tons of iron. The silicon of your mixture should be over 3 per cent, while 4 per cent will do no harm. The phosphorus should be at least 1 per cent. At the back of the cupola between two of the tuyeres and 3 inches below the bottoms of these openings, cut a slag hole, 2½ inches in diameter, and make this opening in the shell about 4 inches wide and 6 inches high. It may be difficult to obtain good limestone in your vicinity, but you can purchase oyster shells, which are much better. Charge 15 pounds of shells or finely broken limestone on each charge of coke; the slag will begin to flow after the fourth charge comes down. I would substitute coke for coal temporarily, although you can use coal again after your difficulties have been solved. Your iron probably comes down hot at first and if so reduce the second half of the coke bed 25 pounds each day until it extends only 18 inches above the tops of the tuyeres. After you have done this reduce the other coke charges 10 pounds each day, provided the iron is hot, and in this way you may be able to reduce the coke charges to 100 pounds. Open a valve when the heat is nearly off so as to slightly reduce the blast pressure. You should have a perfectly clean drop. If the slag is not fluid cast two wedge-shaped blocks of iron and place one in each of the inside tuyere openings on either side of the slag hole. Your difficulty is due to the fact that you are burning too much fuel and have too much ash in the cupola. This ash, without lime, forms a thick slag which rises above the tuyeres and is blown up around the iron and is chilled by the blast. It might also be advisable to have your blast at a maximum pressure of 9 ounces.

We would like to obtain mixtures for phosphor and manganese bronzes suitable for making bushings that must be very hard.

For the phosphor bronze, use the following mixture: Copper, 88 pounds; tin, seven pounds; phosphor-tin, five pounds. For manganese-bronze use copper, 54 pounds; zinc, 40 pounds; tin, one pound; manganese-copper, four pounds, and iron, one pound.

Death of Franklin Farrel

Franklin Farrel, one of the oldest and most successful manufacturers of New England, died at his home in Ansonia, Conn., Jan. 10, after an illness of only about 12 hours. Mr. Farrel was born at Waterbury, Conn., Feb. 17, 1828. His father, Almon Farrel, was famous throughout the Naugatuck valley as a millwright, engineer and builder. When only 14 years of age, Mr. Farrel went to work for his father, learning the trade of a millwright. One of the first plants he aided to erect was a paper mill at Westville, Conn. He went to Ansonia in 1844 and assisted his father in constructing the waterworks and copper mill in the town for Anson G. Phelps. In 1849, Mr. Farrel became associated in the foundry and



FRANKLIN FARRELL

machine business with the firm of Farrel & Johnson. Later the concern was reorganized under the name of the Farrel Foundry & Machine Co., and Almon Farrel became its president, an office which he held until his death in 1857. Franklin Farrel then succeeded to the presidency of this company, and served until his death. The company started with a capital of $15,000, and today has a capital of $1,200,000. The success of the company was due largely to Mr. Farrel's technical skill, shrewd judgment and untiring industry. In 1877, Mr. Farrel went to Butte, Mont., and with his brother-in-law, A. F. Migeon, there formed the Parrot Silver & Copper Co., which proved to be a very successful venture. In 1899, Mr. Farrel and associates sold their control of this company to the Amalgamated Copper Co. Mr. Farrel was also identified with the Bridgeport Forge Co., Bridgeport, Conn., the H. A. Matthews Mfg. Co. and other institutions of Connecticut. For a number of years, he owned a sugar plantation in Cuba and two in Santo Domingo. These interests he disposed of in 1901. Mr. Farrel was always interested in his home city and in everything that made for the good of the community.

Personal

S. Griswold Flagg 3rd has been admitted to membership in the firm of Stanley G. Flagg & Co., Philadelphia.

Glenn Muffly, sales manager of the Adams Co., Dubuque, Ia., has resigned and is now engaged in the preparation of special mechanical advertising with offices at 101 North Canal street, Chicago.

J. N. Battenfeld, vice president and general manager of the Berkshire Mfg. Co., Cleveland, has resigned and has disposed of his interest in that company to engage in the manufacture of a new line of molding machines. A complete range of styles and sizes for light and heavy work has been designed and is now being built. The various types include a combination jar-ramming and squeezer machine; plain jar-ramming machine, jar-ramming roll-over and pattern-drawing machine and plain squeezer. Mr. Battenfeld's present address is 39 Delmont street, East Cleveland, O.

Large Silica Sand Order

The Portage Silica Co., Youngstown, O., miner and shipper of silica and sand blast sand, has received a contract from the National Malleable Castings Co. for its entire steel molding sand requirements for its Sharon, Pa., plant during 1912. The minimum tonnage specified is 30,000, which will require the shipment of 150 tons a day throughout the season of 200 days. The requirements for this shop will undoubtedly total 40,000 to 50,000 tons.

The firm of Scully, Jones & Co., Chicago, has been organized by James A. Scully and Geo. E. Jones, for the purpose of dealing in foundry equipment and supplies, machine tools and railway appliances. Mr. Scully was formerly works superintendent for the Whiting Foundry Equipment Co., Harvey, Ill., and Mr. Jones was in charge of inspection and outside erection for this company.

Book Reviews

Metallurgy, by W. Borchers; translated by William T. Hall and Carle R. Hayward; 271 pages, illustrated; furnished by THE FOUNDRY for $3.

This work briefly outlines the processes involved in the extraction of the more important metals from their ores, and their subsequent refining. The purpose of the work is to afford a means by which a knowledge of modern metallurgical operations can be more easily and quickly obtained than from the more detailed treatises on the subject. The book is not divided into chapters, but each metal is treated separately beginning with gold, and ending with aluminum, and includes both ferrous and non-ferrous metals. Each subject is arranged in a manner convenient for reference, the sources of the metal being first presented in a concise form. Then follows the method by which the metal is extracted from its ores and the manner in which it is refined. Illustration are used as much as possible in describing the furnace and other apparatus necessary to the reduction and purification of the metal, and each subject is concluded with an account of such properties of the metal as specific gravity, color, melting point, conductivity, etc.

The source of cadmium, for instance, is stated to be sulphide, called greenockite, which is of rare occurrence, and is found in the blend of Silesia and North America. Also the carbonate, found only, as a rule, with the smithsonites of Silesia and North America. Other sources are the zinc dust formed in working zinc ores containing cadmium. The extraction of cadmium is a side issue in zinc smelters that work zinc ores containing cadmium, as there are not enough cadmium ores to support an independent industry. The cadmium is obtained partly as metal and partly as carbonate and oxide, and is mixed with from 70 to 80 per cent of zinc and zinc oxide in the first zinc dust obtained, from which the cadmium is reduced by fractional distillation, first in clay and finally in iron retorts, the method of working being the same as in the reduction of zinc except that the temperature is kept lower. The metal is refined by further distillation or by electrolysis, using as anodes, crude cadmium containing zinc and for cathodes, pure cadmium.

The properties of cadmium given in this work follow: Specific gravity, 8.6 to 8.7; color, white; strongly lustrous and soft and ductile. The structure shows a tendency to dendrites on the surface, but otherwise is granular. The crystals grow considerably with long continued heat. Cadmium alloys with most metals. It forms some alloys with remarkably low melting points, instances of which follow: Wood's metal—bismuth, four parts; tin, one part; lead, two parts, and cadmium, one part. Lipowitz metal—bismuth, 15 parts; tin, four parts; lead, eight parts, and cadmium, three parts. The first alloy melts at 160 degrees Fahr., and the second at 140 degrees Fahr.

Maximum Production, by C. E. Knoeppel; 366, 5 x 7½ pages, illustrated. Published by the *Engineering Magazine*, New York City and furnished by THE FOUNDRY for $2.50 net.

The material on which this book is based was largely contained in a series of three articles published originally in the *Engineering Magazine*. The machine shop and foundry, in this work, are considered as twin factors in production—so closely related throughout a vast range of metal manufacturing that their problems can best be studied together. After laying down the principles of organization and management common to efficient operation and maximum success in both kinds of establishments, the author follows special applications of the same ideas, first in the shop and then in the foundry. To the foundry he gives considerable attention, because it has, heretofore, been less thoroughly studied by systematic methods, and yet it offers immense possibilities of profitable improvement since it lies at the foundation of so many mechanical industries. Mr. Knoeppel's experience was gained in the shop and he was later associated as specialist in betterment work with Harrington Emerson and Suffern & Son.

The Technical Analysis of Brass and the Non-Ferrous Alloys, by William Benham Price and Richard K. Meade, 267, 5 x 7½-inch pages; illustrated; published by John Wiley & Sons, New York, and furnished by THE FOUNDRY, Cleveland, for $2. net.

This work is divided into three parts, and is prefaced by an unusually interesting introduction treating of the various alloys used in modern engineering practice and includes tables of alloys suitable for bearings, solders, and fusible metals as well as foundry, rolling mill and miscellaneous uses. The influence of the chemical composition on the physical qualities of the alloys is described, and also their most important applications. A chapter devoted to a description of the apparatus required in conducting electro-chemical analyses follows and concludes the first section.

Analyses of the various metals of which alloys are composed, are discussed in the second section of the work, which contains chapters on the gravimetric, electrolytic and volumetric determinations of aluminum, antimony, cadmium, copper, lead, tin, zinc and other metals and metalloids usually found in alloys. The third part of this volume is devoted to analyses of the different composite alloys, such as German silver, babbitt metals, phosphor bronze, brass, aluminum alloys and refined copper. It is a practical manual, easy to understand by the beginner and handy as a reference for the expert.

Hawkins Mechanical Dictionary; by N. Hawkins, M. E.; 704 pages, 6¼ x 8½ inches; published by Theo. Audel & Co., New York City, and furnished by THE FOUNDRY, Cleveland, for $3.50 postpaid.

This mechanical dictionary is a descriptive wordbook of the meaning and use of terms and phrases currently used throughout the mechanic arts, trades and sciences, including very many of their various applications. A valuable feature of this work is that it is not only a comprehensive dictionary, but is also a cyclopedia of mechanics and technology, thoroughly and accurately compiled. This work contains many tables, formulas, recipes and practical suggestions and a special effort has been directed toward rendering the information given of such practical utility that the work may serve as a trustworthy guide. To this end some simplified rules have been introduced with plain examples of their application. In defining the words, plain mechanical terms and phrases have been used. The book is bound in black cloth with full gold edges and is printed on finely finished paper from large type.

The Independent Pneumatic Tool Co., Chicago, is now manufacturing a new "One Man" drill equipped with compound planetary gears. This drill is particularly adapted for tipping, drilling and screwing-in staybolts and studs in all sizes up to 1¼ inches. The drill weighs only 20 pounds and can be operated by one man. It is equipped with a No. 3 Morse taper socket and has the Corliss valve mechanism with which all of the drills manufactured by the Independent Pneumatic Tool Co. are equipped.

Expansion of Cast Iron

By W. J. Keep

Question:—We build cast iron dies, 6 inches square and 1 inch thick, which are hard, but unfortunately they do not contract upon cooling to the original size, as permanent expansion sets in after they are hardened. The analysis of the iron used for making these dies follows: Silicon, 3 per cent; manganese, 0.50 per cent; graphitic carbon, 3.20 per cent; phosphorus, 0.75 per cent, and sulphur, 0.065 per cent. We have found, that regardless of the amount of heat to which these castings are subjected, the same amount of expansion seems to occur.

Answer:—It does not seem possible that the heat to which a die would be subjected would be sufficient to expand the metal permanently. If you do not desire to change your mixture it might be advisable to make the pattern slightly smaller and by heating the die before using, it will expand to the desired size. If your die is heated to a yellow red, it will expand permanently. The mixture which you are using should produce a very soft iron, although the skin on the outside will be hard. The metal ordinarily used for dies contains a smaller percentage of silicon, but this mixture will shrink more than the one which you are using at the present time. Any mixture of cast iron will permanently expand if heated to redness.

Weighing Iron Mixtures

By W. J. Keep

Question:—As our pig iron storage yard is small, sufficient room is not provided to pile each car of iron separately. We also experience trouble in obtaining intelligent help to make up the mixtures. What would you suggest?

Answer:—You should keep each brand of iron piled separately, provided the cars of each brand are accompanied by analyses cards and if the consumption does not vary greatly, determine the length and width of your piles for the various grades and spread the first car of iron over the entire surface. Each succeeding car load of iron is similarly piled on the preceding lot. When using iron, it should be taken from the end of the pile and an average composition of the pile can be obtained in this way. If particular care must be exercised in making the mixtures, each cupola charge should be carefully arranged on the charging floor in the order in which it is to be charged into the furnace. If a laborer is employed in the pig iron storage yard, it might be advisable to place a board on each pile marked with the number of pigs required for each charge. The laborer then can pile the entire charge on the scale and in this way a fairly satisfactory mixture can be made by inexperienced help. The charges, as a whole, should always be weighed, which include the coke as well as the iron.

Trade Notes

The partnership of Matlack & Bates, Philadelphia, has been dissolved by mutual consent and a new partnership has been formed by F. Warren Marshall and Howard C. Matlack, under the name of Marshall, Matlack & Co. The firm will engage in the sale of pig iron and coke, with offices at 1119 Pennsylvania building, Philadelphia. Marshall, Matlack & Co. will continue the business of Matlack & Bates and have assume all obligations.

Greetings from the management of the American Blower Co., Detroit, to its employes are contained in a handsomely-illustrated booklet issued during the holiday season. The purpose of this publication is to acquaint the employes of this company and their families with the concern with which they are connected. As has been the custom for some years, a considerable sum of money is annually distributed by the American Blower Co., which is based on an allotment of $1 for each year of employment. The booklet contains illustrations of the various works operated by the company. as well as photographs of the officers, department heads and sales representatives.

Air Furnace Practice

By N. W. Shed

Question:—What is considered good air furnace practice melting approximately 20 tons, the charge consisting of 50 per cent of scrap and 50 per cent of pig iron? What time should it take to melt the iron so that it will be sufficiently hot for an average line of castings? What advantage, if any, is there in having a double thickness roof over the furnace? I have noticed that in the Pittsburgh district some of the air furnace roofs consist of a double thickness of bricks, the roofs being about 18 inches thick.

Answer:—Six hours is considered good time for a 20-ton air furnace heat. After the furnace is hot the melting time will, of course, be considerably reduced. Some air furnaces are started at 4 o'clock in the morning and three heats are taken off before 6 p. m. A double thickness roof would prevent the radiation of a certain amount of heat, but in addition it would result in the inside course of bricks melting away more quickly. Two courses of bricks in a roof are, of course, unusual, as only one course of 9-inch bricks is used in the roofs of open-hearth and air furnaces.

Trade Publications

BLOWER APPLICATIONS.—The American Blower Co., Detroit, is sending to the trade a large amount of trade literature, which includes the following publications: "Shop Heating," by F. R. Still; "Ventilation," which describes the use of the Sirocco electric fan and air purifier; "Steel Plate Exhaust Fans" and "Further Fan Facts."

VERTICAL AIR COMPRESSORS. — A bulletin issued by the Gardner Governor Co., Quincy, Ill., is devoted to vertical high speed compressors. This type of machine is simple in construction, requires no outside adjustments, and is dust-proof. The lubrication is automatic, the light valves insuring quiet seating and noiseless operation. The connecting rods are fitted with interchangeable die-cast bushings which are easily renewable. Because of its light weight the compressor may be used to advantage in portable units. The bulletin contains numerous illustrations showing the various models in which this type of compressor is manufactured.

FIRE BRICK.—The Pyro Clay Products Co., Oak Hill, O., has issued a handsomely-illustrated, two-color catalog, devoted to its fire brick shapes. The company's plant is located near Oak Hill in southern Ohio in the famous Portsmouth and Ashland fire brick district. The catalog contains an interesting description of the successive processes of fire brick manufacture. The company's various brands are described and the purposes for which they are used are explained. The illustrations, on a reduced scale, are mechanically correct and contain the dimensions of all of the shapes manufactured by the Pyro Clay Products Co. Interesting data on fire brick are included, as well as a number of useful tables.

POLISHERS' AND PLATERS' SUPPLIES. —In a handsomely illustrated catalog containing 182 pages, the Detroit Foundry Supply Co., Detroit, describes its complete line of polishers' and platers' supplies. Polishing and cleaning compounds are listed, as well as chemicals of all kinds, lacquers, different types of buffing wheels, scouring brushes, tampico wheel brushes, bristle wheel brushes, brass and steel wire and circular scratch and satin finish brushes, etc. Various types of electro-plating dynamos are illustrated and information is included regarding their construction, installation and operation. Other products described, follow: Plating barrels, anodes, voltmeters, tank rheostats, tumbling and burnishing barrels, exhaust fans, vacuum hoods for emery and buffing wheels, glue heaters, glue pots, caldrons, potash kettles, air brushes, spindles for polishing and buffing lathes, complete polishing and buffing lathes of varying types; grinding, polishing and emery wheels; platers' protective clothing

and many other appliances for use in the polishing and plating room.
feet.

AIR COMPRESSORS. — The Chicago Pneumatic Tool Co., Chicago, in three bulletins, illustrates and describes its line of railroad type, duplex steam and belt-driven air compressors. The construction of the railroad type of compressors follows heavy duty engine practice, the frame being of the semi-tangye type with bored guides and side cranks. The steam and air cylinders are arranged tandem with heavy tie rods, and are further supported by a heavy sole plate. The air cylinders are completely water-jacketed; the steam valves are of the balanced type and an improved steam governor and speed regulator with an unloading attachment is provided, so that the engine is at all times under perfect control. The Chicago pneumatic type of compressors described, constitute self-contained air power units, that can be installed in places where space is restricted and extensive foundations undesirable. A third bulletin contains general instructions for the installation and operation of these various compressors and gives a list of the different parts of the machines for convenience in ordering repairs.

FANS.—"Conoidal" fans, manufactured by the Buffalo Forge Co., Buffalo, are described in a 48-page catalog, recently issued. This type of fan derives its name from the prevalence of conical shapes in its design. The inlet is conical, the blast wheel forms the frustrum of a cone and the blades are curved over the tapering surface of a cone. The advantages claimed for this fan are in its design which insures great structural strength and rigidity. The suction, it is claimed, produced at the inlet of multiblade fans tends to draw the air in almost at right angles to the back or drive side. Striking the plate, the air is suddenly deflected at an angle of 90 degrees toward the blades and outlet. This abrupt change of direction causes loss of power and velocity. In the design of the "Conoidal" fan, means have been provided for counteracting these tendencies, thereby securing an increased efficiency. The blades are narrow at the front, providing a large and unobstructed intake. They increase in width toward the back, causing part of the air to be taken up by them before striking the hub. The hub is made conical to gently deflect the air toward the blades, without loss of power. The inner side of the blades at the back meet the base of the cone, taking up the air at a slow speed because of the small diameter. To offset this slower speed, the blade is made wide at the back, increasing the pressure. The width of the blade decreases toward the front where its higher velocity produces a greater suction. The fan is particularly adapted for heating and ventilating installations.

General Industrial Notes

The firm name of E. M. Burr & Co., Champaign, Ill., has been changed to the Burr Co.

Cook, Troup & Hammond, Little Falls, N. Y., have completed the erection of a foundry and machine shop on West Mill street. The plant is 28 x 64 feet.

Frederick Kahl, Detroit, manufacturer of machinery castings, has incorporated his business with a capital of $100,000. It will be operated under the firm name of the Frederick Kahl Iron Co.

The Brillion Iron Works, Brillion, Wis., has completed its new foundry, which is 60 x 120 feet, with a wing, 30 x 50 feet. The equipment includes a 60-inch Whiting cupola. The old plant will be converted into a machine shop.

The Scullin-Gallagher Iron & Steel Co., St. Louis, has placed a contract with the Alliance Machine Co., Alliance, O., for a 45-ton pouring crane. A turbine air compressor will also be furnished by the Ingersoll-Rand Co., New York City.

The Humphrey Pipe & Foundry Co., Bellefontaine, O., has been incorporated with a capital of $10,000. The incorporators are Chas. S. Humphrey, Harry H. Morrow, F. D. Batch, Eva D. Humphrey and Nellie D. Morrow.

The plant of the Shirley Radiator & Foundry Co., Shirley, Ind., was totally destroyed by fire on Jan. 9, entailing a loss of nearly $400,000. Work will be commenced immediately on a new plant, which, it is stated, will have even a greater capacity than the one destroyed.

J. C. Lankford and B. Martin, Terrell, Tex., have leased the Central Iron Works, owned by Wm. Bus and Hans Koch. Mr. Lankford was for eight years connected with the Mosher Mfg. Co., Dallas, Tex., and Mr. Martin is a practical machinist of wide experience. Sash weights, boiler fronts and other gray iron and brass castings will be manufactured.

The Reliance Gas Regulator & Machine Co., Pasadena, Cal., has been incorporated with a capital of $100,000 to engage in the manufacture of high and low pressure gas regulators and all classes of gas and automatic machinery. A new plant has recently been completed, which includes a machine shop, 80 x 185 feet; foundry, 80 x 185 feet, and a pattern shop, 40 x 60 feet.

New Construction

The Palmetto Iron Works, Greenville, N. C., are erecting a foundry, 40 x 117 feet.

The Zuttle & Bailey Mfg. Co., Bridgeburg, Ont., contemplate the erection of a foundry.

The Cream City Foundry Co., Milwaukee, will erect an addition, 100 x 70 feet, to its foundry on Oklahoma and Fifteenth avenues.

The A. L. Swett Iron Works, Medina, N. Y., contemplate the erection of a large foundry early next year.

Mohr & Kershner, Reading, Pa., iron founders, are erecting a new foundry, 52 x 178 feet. Sand blast machinery, boilers, engines, cupola and other foundry equipment will be installed.

Wm. R. Thropp & Sons Co., Trenton, N. J., has had plans prepared for a foundry, 80 x 250 feet, which will be equipped with motor-driven tools and a traveling crane.

The Ohio Crucible Steel Co., Shaw avenue, Cleveland, is erecting a one-story addition to its foundry, 32 x 64 feet. Air compressors, sand blast and open-hearth foundry equipment will be required.

The Blake Specialty Co., Rock Island, Ill., is erecting a new plant, including a foundry, 80 x 100 feet; core and cupola rooms, each 20 x 30 feet; cleaning room, 30 x 45 feet; machine shop, 80 x 75 feet, and a heating plant and pumping station, 30 x 45 feet.

Isaac A. Sheppard & Co., Philadelphia, have purchased seven acres of land near Frankford Junction, fronting on Erie avenue and extending more than 700 feet along the line of the Pennsylvania railroad, on which will be erected a group of buildings, including a foundry, for the manufacture of stoves, ranges, furnaces, hot water and steam boilers, etc.

Among the Brass Founders

The Columbia Brass Works, Los Angeles, Cal., is erecting a two-story foundry, 50 x 117 feet, for the manufacture of brass, bronze and aluminum castings.

The Clark Novelty Co., Rochester, N. Y., has taken over the plant of the American Draft Furniture Co. and will erect a new brass foundry.

The Mayer and Englund department of the Electric Service Corporation, Philadelphia, is considering the installation of a brass foundry in its recently completed plant at Seventeenth and Cambria streets.

The Atwater-Kent Mfg. Co., Philadelphia, has purchased a two-acre tract on Stanton avenue, on which it will erect a plant, 166 x 120 feet, including a brass foundry, for the manufacture of automobile and electrical specialties.

The Central of Georgia railroad has added a brass foundry to its plant at Macon, Ga., in which Steele-Harvey brass melting furnaces have been installed by the Monarch Engineering & Mfg. Co., Baltimore.

C. J. Rath, formerly president and general manager of the Alliance Brass & Bronze Co., Alliance, O., has established a brass foundry at Marion, O., which will be operated under the firm name of the Marion Brass & Bronze Co.

The firm name of the Millet Brass Co., Springfield, Mass., has been changed to Millett & Hardy. There has been no change in the management, and brass, bronze and aluminum castings will continue to be manufactured.

The American Welded Chain & Ring Co., New Brunswick, N. J., has been incorporated with a capital of $25,000, to engage in the manufacture of welded wire chains, rings, castings, forgings, etc. The incorporators are C. C. Thatcher Jr., J. E. Alexander and Wm. E. Sperling, all of New Brunswick.

E. T. Wood, Lyndonville, Vt., a well-known brass founder, has acquired an interest in the Springfield Brass Foundry, Springfield, Vt., and will engage in the manufacture of brass castings. The officers of the Springfield Brass Foundry are: E. T. Wood, president and general manager; F. B. Gill, secretary and treasurer, and P. E. Luther, superintendent.

The American Brass Co. has been incorporated with a capital of $15,000,000 to take over the following concerns, which will hereafter be operated as branches of the American Brass Co. under the names of the corporations: Ansonia Brass & Copper Co., Ansonia, Conn.; Benedict & Burnham Mfg. Co., Waterbury; Coe Brass Mfg. Co., Torrington and Ansonia, and the Waterbury Brass Co., Waterbury, Conn.